July 2024

PLANT-BASED FERMENTED FOODS

EUROPEAN CONSUMER ATTITUDES AND PREFERENCES

PRELIMINARY FINDINGS FROM THE HEALTHFERM CONSUMER SURVEY

HealthFerm

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"The HealthFerm project aims to create plant-based fermented foods that offer health benefits to consumers. To ensure success in these endeavors, a dedicated consumer work-package has been established to gather insights on the preferences for the next generation of fermented plant-based foods. This pioneering study provides valuable guidance for developing innovative fermentations that align with sensory expectations. Furthermore, the report highlights the significant market potential for fermented plant-based foods."

- Prof. Christophe Courtin
KUL - HealthFerm Project Coordinator

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PREFACE

ACKNOWLEDGEMENTS

This study was designed supervised by researchers from Umeå University's Research Group Sustainable Transitions. Data visualizations and report content were prepared by Bridge2Food, while the Umeå University team arranged graphic design for the final report.

To learn more about the HealthFerm project and its partners, visit:
www.healthferm.eu

ACCESSIBILITY

For convenience and accessibility of offline and print readers, all charts are included in the report. Readers with access to an internet connection can explore interactive versions of all charts at the following link: https://research.bridge2food.com/healthferm/wp4survey

The Open Access version of this report is available at www.healthferm.eu and Zenodo (DOI: 10.5281/zenodo.1254273) under a Creative Commons Attribution-NonCommercial (CC-BY-NC) 4.0 International license.

SCOPE

All content presented in this report is preliminary. It represents initial findings based upon descriptive statistics only, and discussion of these results should be considered in this context. Further analyses and predictive behavior models will be carried out separately to produce more robust conclusions for scientific publication.

Please direct questions and comments to armando.perez@umu.se

FUNDING

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EXECUTIVE SUMMARY

INTRODUCTION

Fermentation has the potential to improve the taste, health and sustainability of modern diets. By harnessing the power of both ancient and cutting-edge technologies, fermentation can improve the sensory, nutritional, and environmental profiles of many foods, as well as be used to create new kinds of food products. But realizing this potential ultimately depends upon consumers. HealthFerm researchers surveyed **7812 European consumers** across nine countries to gain insight into their behavior, preferences, and attitudes toward **plant-based fermented foods**.

DIETARY LIFESTYLE

Survey findings revealed diverse dietary patterns and lifestyles among European consumers. Omnivores made up the majority, accounting for 75% of respondents, followed by **16%** that **identified as flexitarian**. Flexitarians had a notable prevalence among respondents residing in Germany, where 30% reported this as their dietary lifestyle. Higher education level and financial stability were strongly correlated with plant-rich dietary lifestyles (thus including fewer animal products), while younger respondents were also more likely to identify as vegetarian or vegan than those in older age groups. The main reason why people change their dietary lifestyle is **health**.

Omnivore

I frequently eat meat such as beef, pork, chicken, turkey, fish and/or shell-fish

Flexitarian

I sometimes eat meat, but I am trying to reduce my meat consumption and often choose plant based foods instead

Pescetarian

I eat fish and/or shell-fish, but no other types of meat

Vegetarian

I don't eat meat and fish of any kind, but I do eat eggs and/or dairy products

Vegan

I don't eat meat, fish, eggs, dairy products, or any other animal-based ingredients

Plant-based fermented foods are defined as "foods made through desired microbial growth and enzymatic conversions of components from plant-based foods."

A plant-based diet consists of minimally processed fruits, vegetables, whole grains, legumes, nuts and seeds, herbs, and spices and excludes all animal products, including red meat, poultry, fish, eggs, and dairy products.

CONSUMPTION AND CHANGE

A quarter of Europeans eat their fruits and veggies on daily basis. Yet adherence to recommendations for healthy and sustainable eating are not practiced by the majority. Dairy is the most frequently consumed food group, with 46% of respondents consuming dairy products once per day or more. Meat was also a staple in respondent diets, although there was a trend toward reducing meat consumption, especially among flexitarians. However, 27% of **omnivores eat meat less than three times a month,** indicating a shift towards reduced meat consumption and a growing market opportunity for alternative proteins. While plant-based meat and dairy products were reported least frequently consumed, plant-based dairy showed particular promise with 10% of respondents consuming plant-based milk at least once per day, and 11% consuming plant-based fermented yogurt 4-6 times per week or more. White and sourdough breads were the most recognized and consumed plant-based fermented foods, while tempeh was the least recognized fermented product.

PERCEPTIONS, MOTIVES, AND BARRIERS

Taste preference was the overall primary reason for dietary choices, followed by personal health and animal welfare, although priorities varied across dietary lifestyle groups. Environmental sustainability, while important, ranked lower than taste and health. Key barriers to plant-based food consumption included resistance to changing eating habits, perceived inconvenience, and lay beliefs about satiety and taste. For fermented plant-based foods, clean labels and organic/bio certifications were important. However, respondents expressed uncertainty about the health and sustainability benefits of fermented plant-based foods over other foods.

MARKET OPPORTUNITIES

Respondents preferred fermented plant-based meat and milk alternatives priced at parity with animal-based products rather than those priced lower, indicating **quality expectations. Traditional** fermentation was the most accepted type of fermentation, followed by **precision** and **biomass** fermentation, although levels of acceptance varied across dietary lifestyle, geography, age, education, and socioeconomic groups. Younger, educated, and financially secure respondents show greater willingness to try products prepared through all fermentation technology categories.

TRUST IN PLANT-BASED FERMENTED FOODS AND TECHNOLOGIES

Trust levels vary according to the countries, with a somewhat of a concentrical gradient. Trust is the higher in Finland, followed by Italy and Romania, probably reflecting traditional use of fermentation. They are followed by Denmark and Belgium, with the lowest trust found in Germany. Overall, in the EU, consumers expressed high trust towards the processes of traditional, precision and biomass fermentations. Participants currently trust the companies and the products obtained.

SENSORY PREFERENCES

For plant-based fermented **yogurt and drinkable yogurt**, consumers prefer white, creamy, sweet, and uniform products with a grainy aroma, but without beany flavours or smells. Important characteristics for fermented plant-based **chicken alternatives** include even colour, natural shape, chicken-like odour, salty and spicy flavors, and a tender, uniform texture. Yeasty, sour, and beany flavours should be avoided. For **protein-enriched breads**, consumers prefer small air bubbles, cohesiveness, roasted and nutty aromas, a fermented flavour, and a crispy yet soft texture.

CONCLUSION

The study reveals a significant interest in and potential for plant-based fermented foods among European consumers. However, overcoming barriers related to familiarity, convenience, and taste is essential. These findings can help inform targeted strategies leveraging preferred sensory attributes, ingredient preferences, and clear labeling to enhance consumer acceptance and market penetration for plant-based fermented food products. A systems approach integrating consumer education, research and product development are needed to bridge the gap between current perceptions and the potential benefits of plant-based fermented foods.

INTRODUCTION

WHAT IS FERMENTATION?

Fermentation is an ancient form of biological food processing. Since at least 6000-4000 BCE[1], microorganisms have been cultivated to transform raw agricultural products into more nutritious, delicious, and shelf-stable foods and beverages. Pickles, wine, and bread are just a few examples common in European diets.

Today, there are roughly 5000 different fermented foods and drinks consumed around the world, accounting for 5-40% of the human diet[2], depending upon geography and cultural context.

While some techniques remain largely unchanged from millennia-old traditions, fermentation has also evolved to include new methods and applications.

Scientists and engineers now harness the power of microorganisms to create foods, medicines, and industrial products with wide-ranging uses. For instance:

- Yeasts – the previously wild microorganisms used in breadmaking, winemaking, and beer brewing are now domesticated and optimised to make what producers and consumers want in the volumes they demand
- Insulin – the life-saving medicine previously sourced from livestock is now produced using precision fermentation to make safer and more effective insulin for diabetics
- Whey – the dairy protein traditionally sourced from cows is now also produced through precision fermentation without the need for animal farming

1 Ray, 2014, Fermented Foods: Past, Present and Future
2 Hutkins, 2019, Microbiology and Technology of Fermented Foods

WHY IT MATTERS

Science-based dietary guidelines and sustainability targets call for significant change to current eating patterns. Specifically, increasing consumption of whole plant foods and decreasing consumption of animal products are necessary, both to mitigate diet-related public health crises and to lower risk of potentially catastrophic shifts in the Earth's ecosystems.[3]

Such findings have helped elevate food and agriculture to the top of European policy agendas and placed these topics at the heart of frameworks such as the European Green Deal[4]. Within this framework, the Farm to Fork Strategy[5] tackles both unsustainable livestock farming practices as well as the sustainability of consumer demand.

However, most consumers in the world's wealthiest countries do not want to change their eating habits. At the same time, consumers in the world's least developed countries, where populations are growing fastest, are likely to increase their consumption of animal products in coming decades.

This presents a dilemma for policy makers, public health, and the planet.

The Horizon Europe programme serves as one lever for change within the Farm to Fork Strategy, addressing this dilemma by supporting research to increase the availability of non-animal protein sources and meat substitutes[6] that can bridge consumer demands with European health and sustainability targets.

3 https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31788-4/abstract

4 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/agriculture-and-green-deal_en

5 https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

6 https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_885

HOW FERMENTATION CAN HELP

Many currently available plant-based meat and dairy substitutes fail to meet consumer demands for taste, texture, and culinary performance. When considering a plant-based substitute, consumers also want to know they are not compromising on nutrition.

Fermentation can be used to transform plant materials into products that consumers crave, and which are nutritious and more easily digestible than the raw products from which they are made:

- For millennia, fungi have been utilized in to create the rich umami flavours associated with East Asian cuisines from the simple, relatively bland soybean
- In Indonesia, another species of fungus is utilized to transform legumes and grains into tempeh, a popular staple food with a meaty texture and better digestibility than the raw materials from which it is made
- More recently, a new wave of innovative food companies and culinary experimentalists are exploring applications of fermentation to create a broad array of products that closely resemble animal-based foods, but without the associated health and sustainability drawbacks

However, much of this more recent innovation has taken place in the context of small startups and private companies unable to conduct extensive research on all the impacts of fermentation processes. As a result, little scientific evidence exists examining the potential of fermentation to address Europe's health and sustainability challenges. Even less is known about how consumers think and feel about fermentation and fermented food products.

This study represents a step toward addressing these knowledge deficits.

DIET

DIETARY LIFESTYLE

Mainstreaming Meat Reduction

Among 7812 consumers surveyed, 16% identified as flexitarian, indicating they are trying to reduce meat consumption and often choose plant-based foods instead.

Within this segment, Germany stood out with 30% of respondents having identified as flexitarian, followed by France, Switzerland, and Belgium, among which flexitarians accounted for 18–20% of respondents.

For other countries in the sample, flexitarians made up a wide-ranging portion of respondents, from just 6% (Finland) to 14% (Romania).

At a glance, age alone does not appear to be a strong predictor of whether respondents identified as flexitarian. However, education level and socioeconomic status play a bigger role. Respondents with a graduate degree were nearly twice as likely to identify as flexitarian when compared with those whose highest educational attainment was primary school. Socioeconomic status showed a similar trend, though to a less pronounced degree.

Higher education level and socioeconomic status are associated with lower consumption of animal products

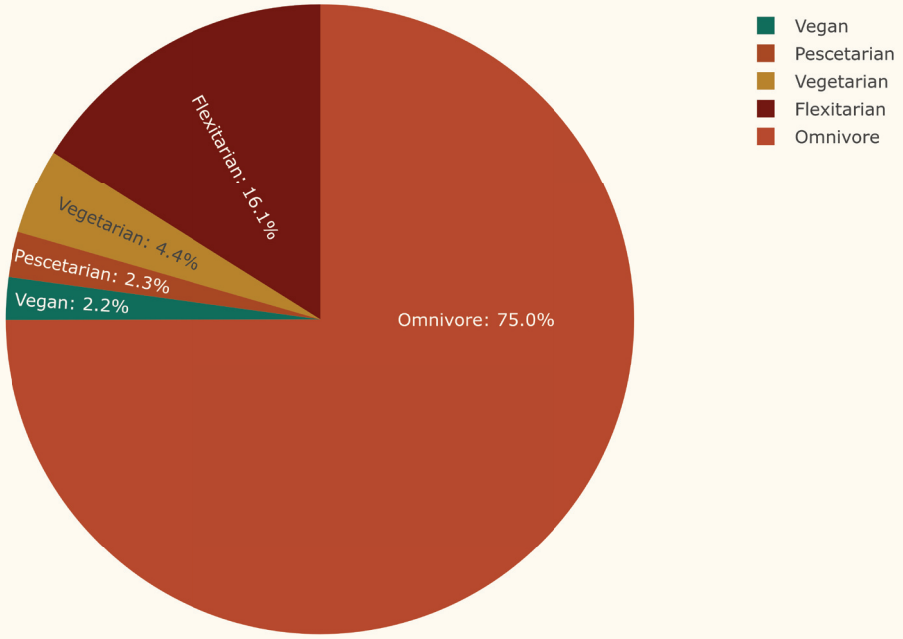
Omnivores represented 75% of all survey respondents, indicating that 25% were intentionally reducing, or had removed, animal products from their diets to varying degrees. About 27% of them eat meat less than 3 times in the month, without necessarily identifying themselves as flexitarians. This suggests that a diet shift is starting to happen among average citizens, reaching a societal tipping point. The consequence is a renewed market opportunity for alternative proteins in general.

Figures range widely across countries – Switzerland counted nearly 11% of respondents identifying as vegetarian or vegan, while at the other end of the spectrum, Belgium counted just 4%. Interestingly, respondents residing in Italy were the most likely to identify as vegan, with 6% selecting this as their dietary lifestyle.

Unlike with flexitarians, age appears to play a role. Respondents identifying as vegetarian or vegan represented 10% of the 25–34 age group, with the figure decreasing to just 3% for those aged 65 and over.

Like the flexitarian group, education level seems to be a strong predictor of whether respondents identify as vegetarian or vegan. 2% of respondents with an undergraduate degree identified as vegan, which is twice the level of those whose highest level of educational attainment was secondary school. Those holding a graduate degree were also nearly twice as likely to identify as vegan as those whose highest education completed was at the undergraduate level.

Socioeconomic status tells a similar, but slightly different, story. Respondents who described their financial situation as "extremely easy" were more than twice as likely to identify as vegetarian or vegan than those who described their financial situation as "neither easy nor difficult." Findings were mixed for respondents that described their financial situation as "somewhat difficult" or "extremely difficult."



*1. Which of the following represents best your **dietary lifestyle**?*

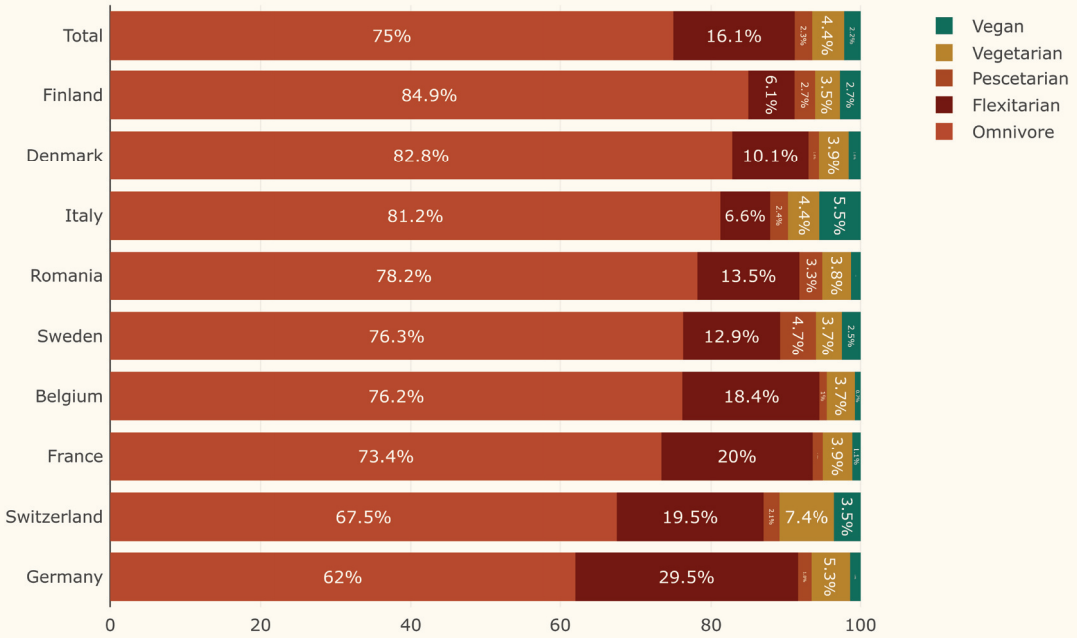
Omnivore (I frequently eat meat such as beef, pork, chicken, turkey, fish and/or shell-fish)

Flexitarian (I sometimes eat meat, but I am trying to reduce my meat consumption and often choose plant based foods instead)

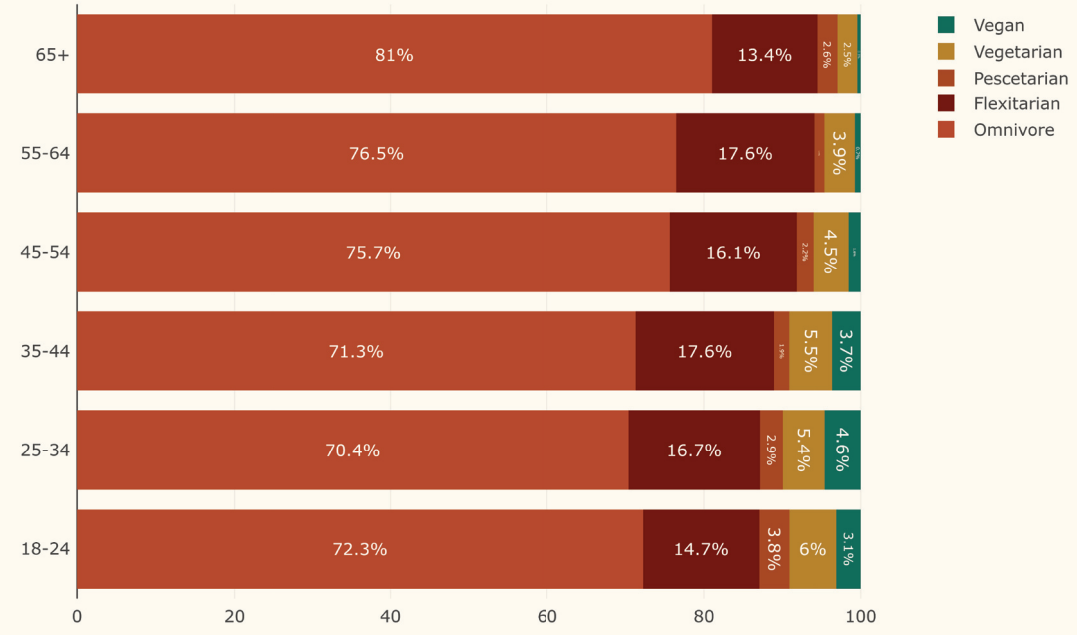
Pescetarian (I eat fish and/or shell-fish, but no other types of meat)

Vegetarian (I don't eat meat and fish of any kind, but I do eat eggs and/or dairy products)

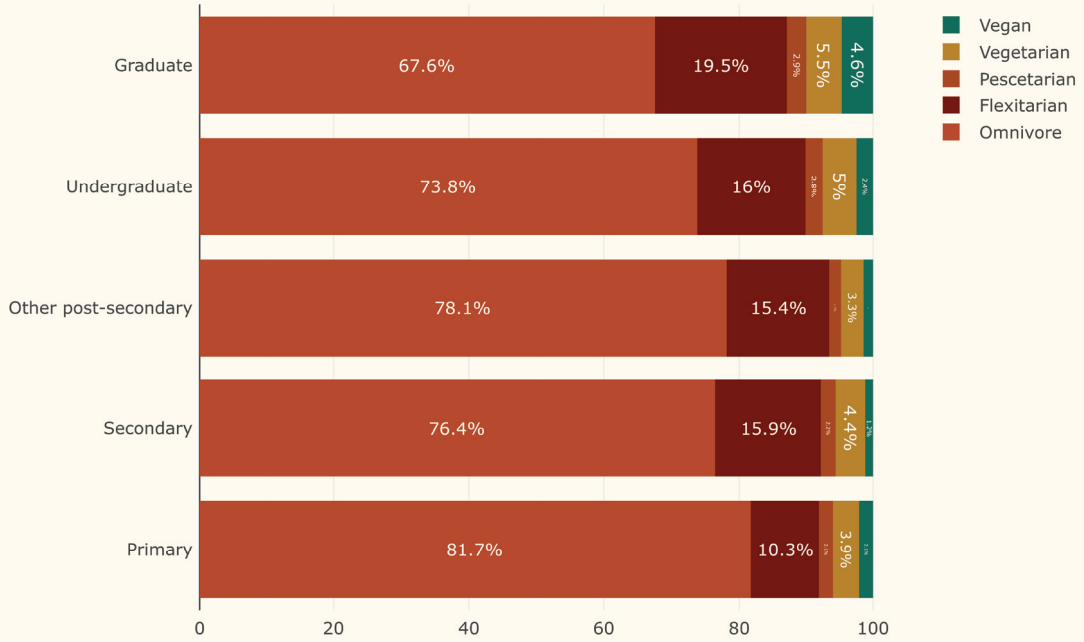
Vegan (I don't eat meat, fish, eggs, dairy products, or any other animal-based ingredients)



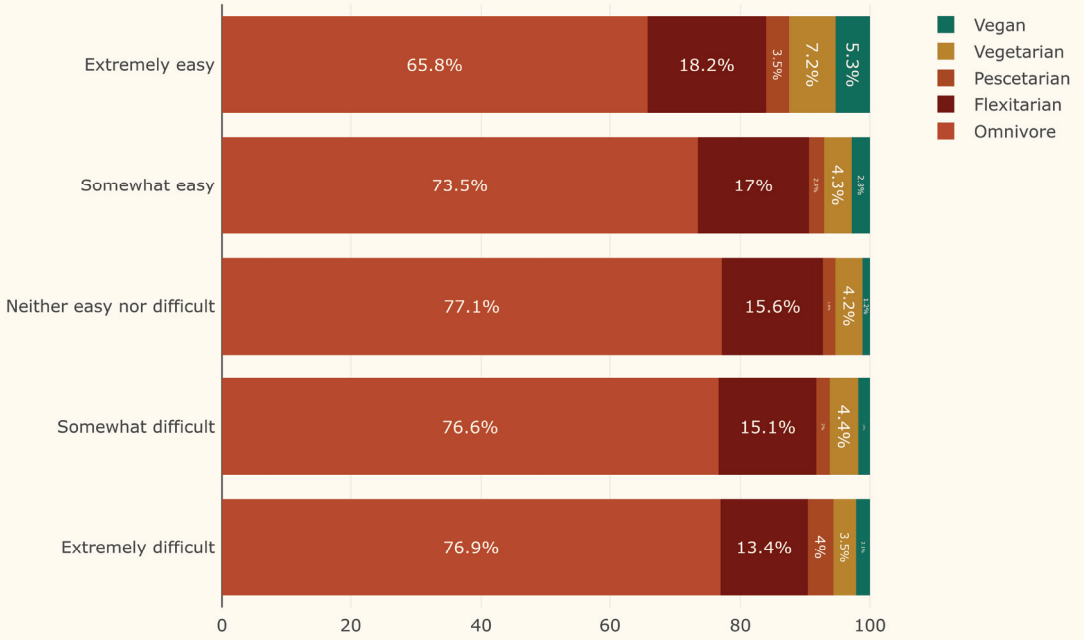
2. Dietary lifestyle by Country



3. Dietary lifestyle by Age Group



4. Dietary lifestyle by Education Level



5. Dietary lifestyle by Socioeconomic Status

REASONS & IMPORTANCE

Taste preference is the most important reason for maintaining dietary lifestyles

When asked to rank in order of importance ten different reasons for adhering to their dietary lifestyle, respondents overwhelmingly ranked "taste preference" as most important.

This reason ranked highest for 55% of all respondents, more than double that of "personal health," which was most important for 24%, the next most popular choice. Animal welfare was the third most selected reason, ranked as most important for 19% of respondents.

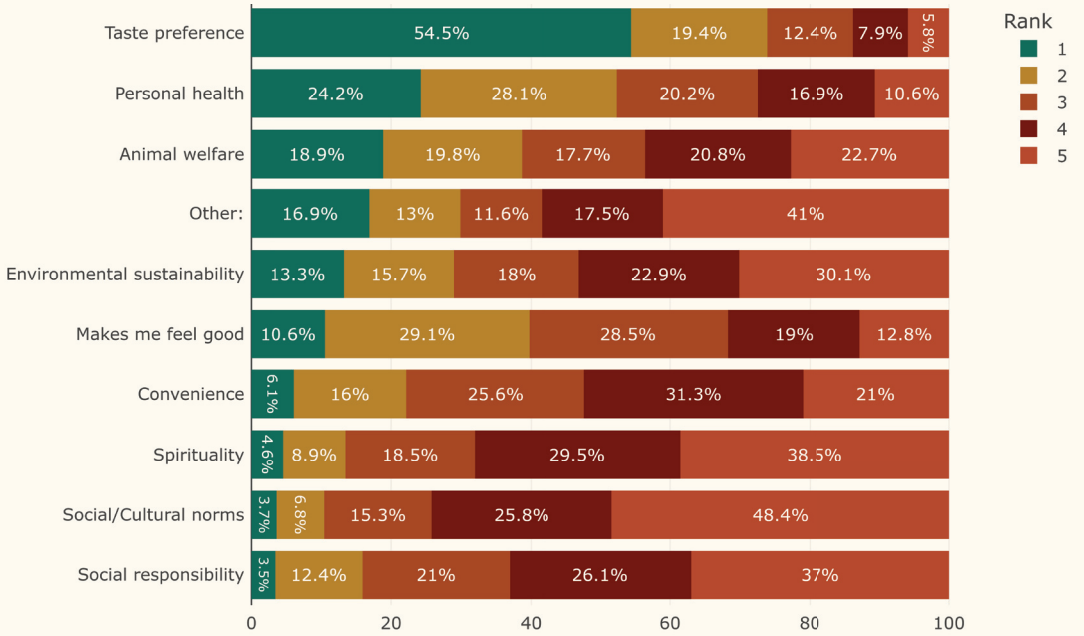
However, these aggregate figures largely reflect the rankings of omnivores and flexitarians, the most representative groups in the sample. Breaking down importance rankings by diet, we find:

Omnivores – Taste preference trumps all other reasons, with 54% of omnivores ranking it as most important. Next, personal health was ranked as most important for 20%, followed by "makes me feel good," which was most important for 9% of omnivores.

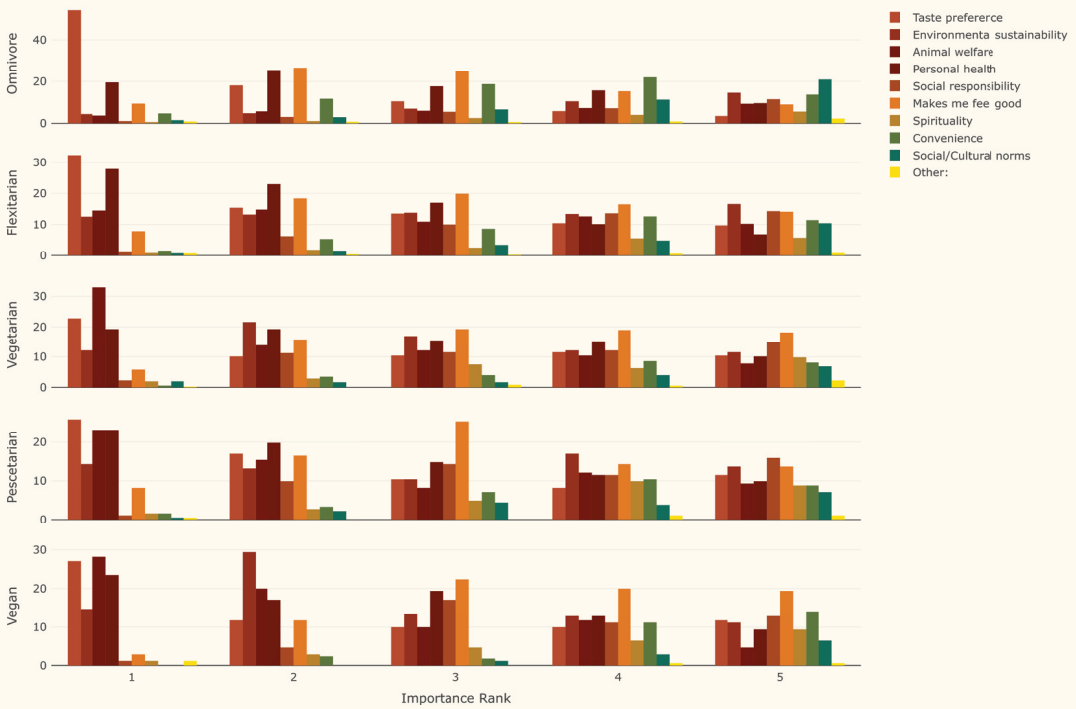
Flexitarians – Taste preference was also most important for flexitarians, with 32% ranking it first. But unlike omnivores, this figure was only slightly higher than personal health, which was most important for 28%. The next reason ranked as most important for flexitarians was animal welfare, at 15%.

Pescatarians – Similar to flexitarians, taste was also most important, with 26% ranking it first. But animal welfare ranked significantly higher for pescatarians than flexitarians, with 23% ranking it as most important, tied with personal health, which was ranked most important by another 23%.

Vegetarians and vegans – For respondents that identified as vegetarian or vegan, animal welfare was most important. The second and third most popular selections for both groups was taste preference and personal health, respectively. However, for vegetarians, animal welfare was relatively more important than for vegans, who prioritized taste preference and personal health at similar levels.



*6. Rank, in order of **importance**, the **reasons** for which you adhere to this diet (only the top 5 will be taken into consideration)*



7. By Diet

Personal health is the primary driver of dietary change

Most respondents had followed their dietary lifestyle since birth. However, 40% reported having changed their dietary lifestyle. Among those who had made such a change, 69% switched from omnivore to a diet containing fewer or no animal products.

When asked to select the main reason for this switch, 31% chose personal health. Taste preference was the next most popular reason, selected by 22% of respondents, followed by animal welfare, selected by 16%.

Environmental sustainability also matters to consumers

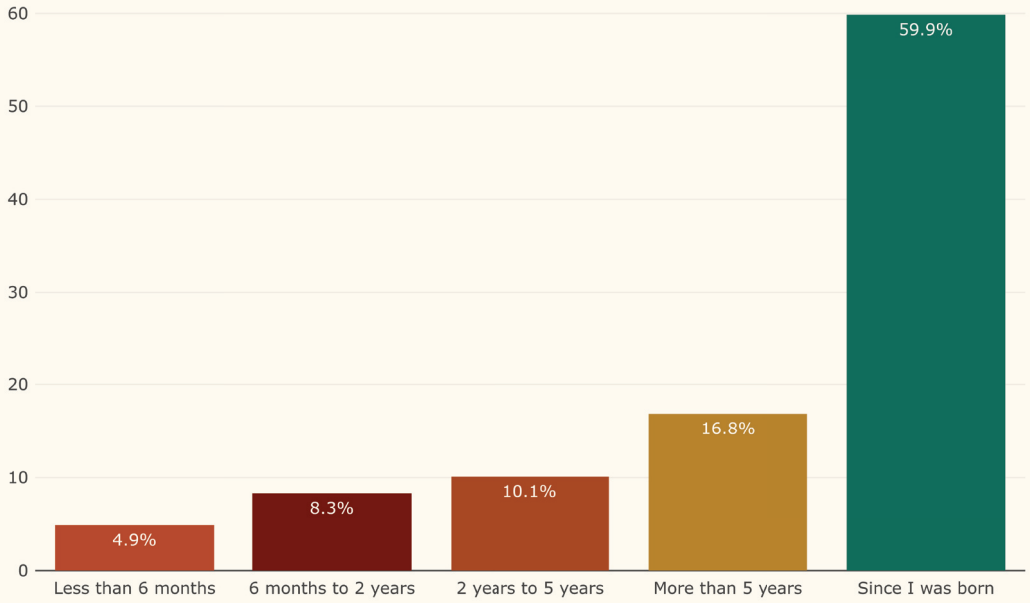
When asked to rank the importance of ten reasons for adhering to their current dietary lifestyle, and when asked to select the main reason for change, environmental sustainability consistently ranked among the top five. For most groups, it was the fourth most selected reason after taste, health, and animal welfare.

Only respondents that identified as omnivores ranked it fifth, after convenience, which was of considerably lower importance to other dietary lifestyle groups.

Omnivores rank animal welfare as low importance for their dietary lifestyle

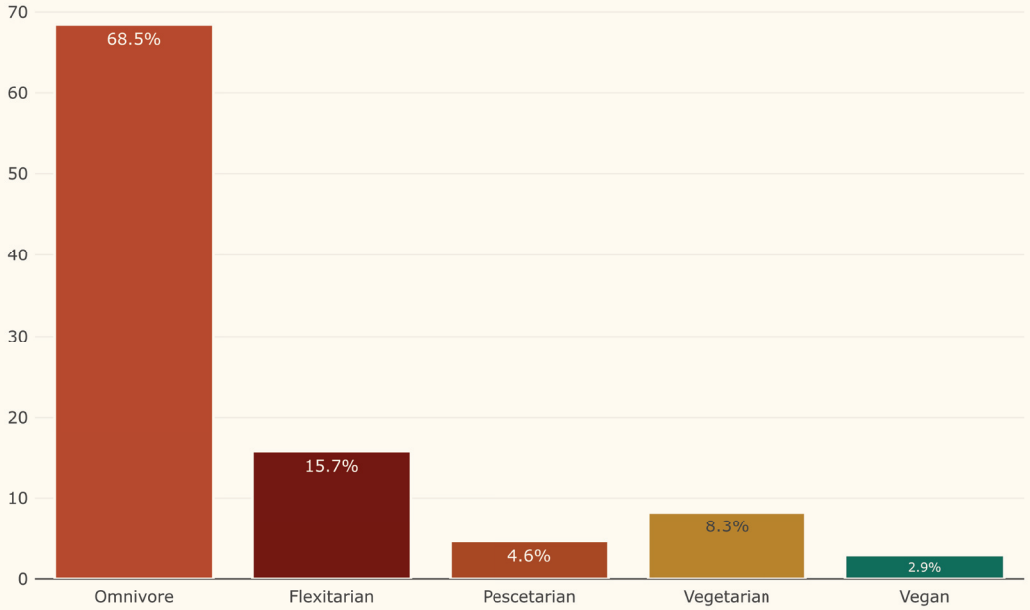
For all lifestyle groups other than omnivores, animal welfare was among the top three main reasons for adhering to their diet. For respondents who identified as omnivore, however, animal welfare was the sixth most selected reason following taste, health, makes me feel good, convenience, and environmental sustainability.

DURATION



*8. For **how long** have you been following your current dietary lifestyle?*

CHANGE



*9. What diet did you **switch** from?*

DIETARY CHANGE

Meat consumption is changing... slightly

Among respondents who identified as omnivore or flexitarian, 53% reported "no change" in their meat consumption over the past year. However, those that reported a change were far more likely to be consuming less rather than more – 40% indicated they were consuming "slightly less" or "a lot less" compared to just 7% who reported consuming "slightly more" or "a lot more."

But these figures largely reflect the behavior of omnivores, who comprised a larger portion of respondents than flexitarians. Breaking down change in meat consumption by dietary lifestyle:

65% of **omnivores** reported consuming the same amount or more meat than a year ago, while 35% reported consuming slightly or a lot less

39% of **flexitarians** reported consuming the same amount or more meat than a year ago, while 61% reported consuming slightly or a lot less

When asked about their intentions over the next six months, responses were similar: 65% of respondents indicated they will consume "about the same" amount of meat.

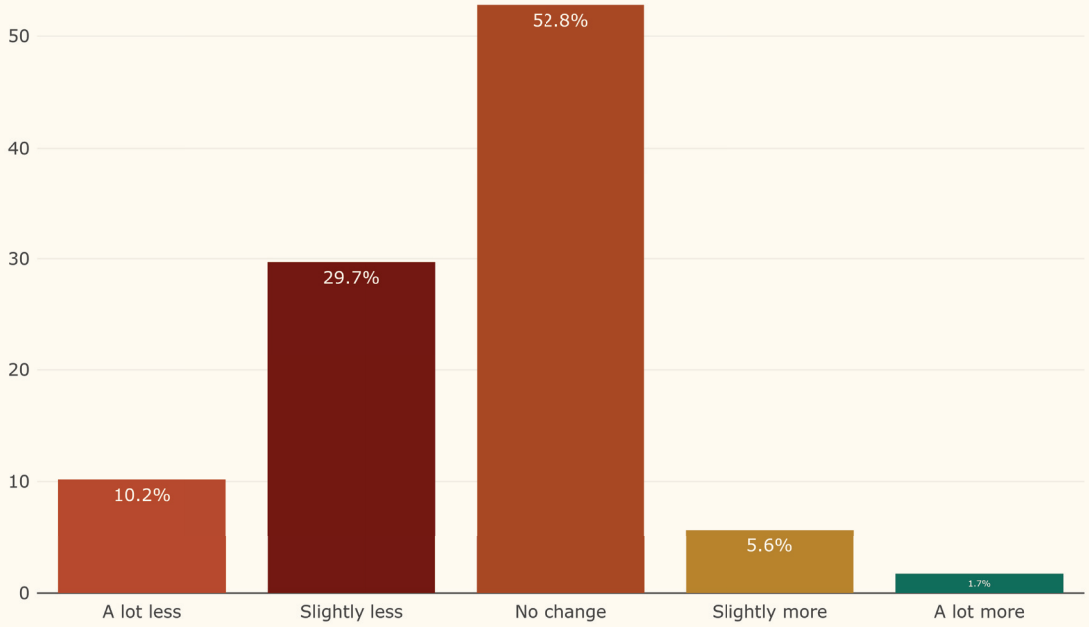
Those that reported an intention to change were much more likely to consume less than more – 28% reported they will consume "a little less" or "a lot less" compared to just 8% who reported intentions to consume "a little more" or "a lot more."

Breaking down intentions to change meat consumption by dietary lifestyle:

76% of **omnivores** indicated they will consume the same amount of meat or more, while 24% reported intentions to consume a little or a lot less

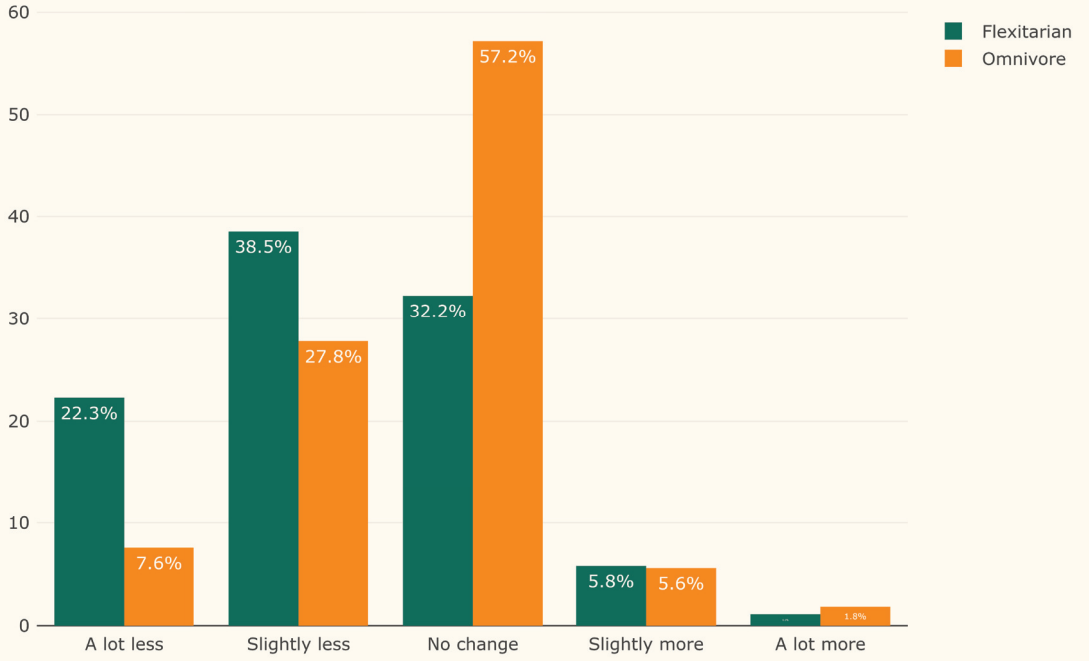
56% of **flexitarians** indicated they will consume the same amount of meat or more, while 45% reported intentions to consume a little or a lot less

12-MONTH CHANGE – MEAT CONSUMPTION



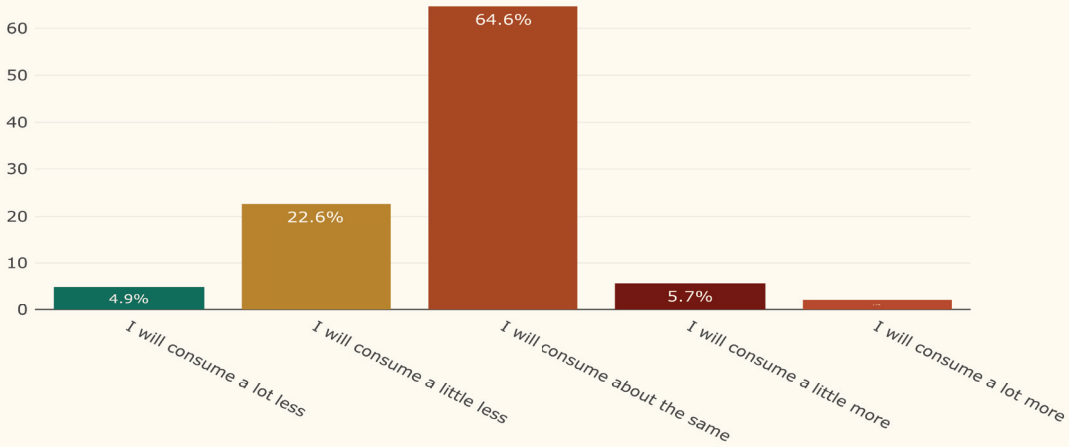
*10. Compared to a year ago, how much **meat** (e.g., beef, pork, chicken...) are you eating now?*

* Question only presented to respondents that identified as omnivore or flexitarian



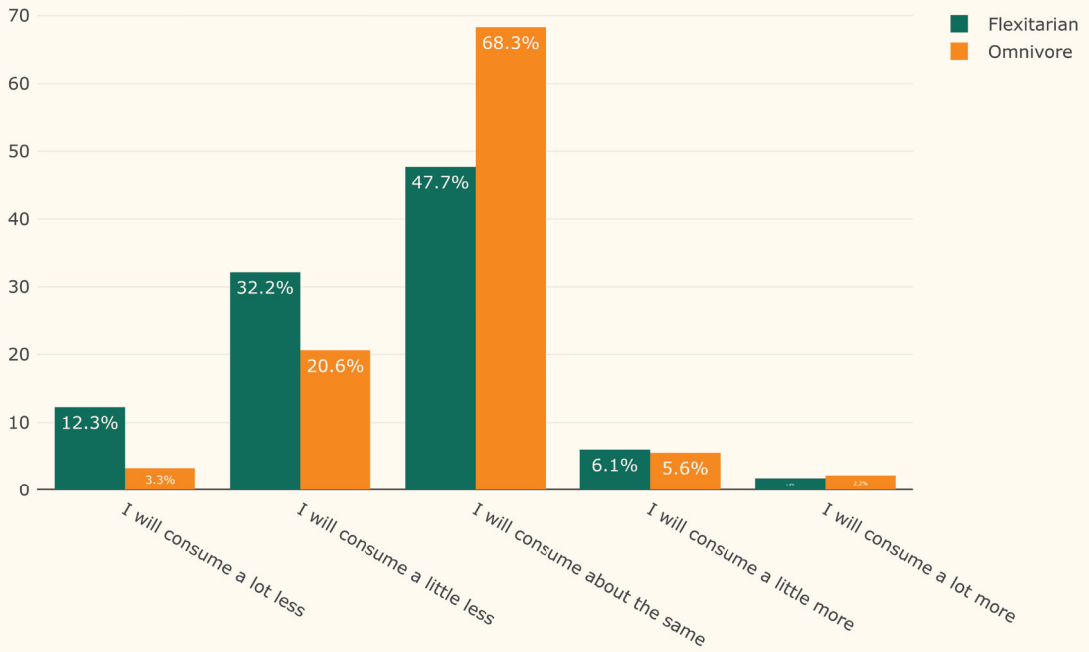
11. By diet

MEAT



*12. Do you intend increasing or reducing your consumption of **meat products** (e.g., beef, pork, chicken, etc.) in the next 6 months?*

* Only asked to respondents that identified as omnivore or flexitarian



13. By Diet

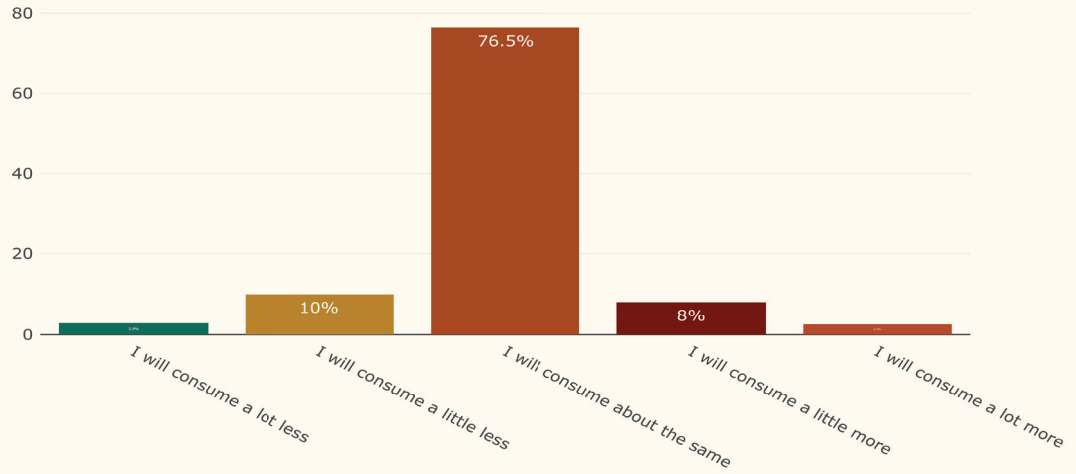
Dairy consumption is harder to change

Compared to meat, respondents showed less willingness to change dairy consumption habits, with 77% reporting they intend to consume "about the same" amount over the next six months.

Among those who indicated an intention to change, 13% reported they will consume less, while 11% reported they will consume more. Breaking down intentions to change dairy consumption by dietary lifestyle, there is also less variation between omnivores and flexitarians when compared to meat:

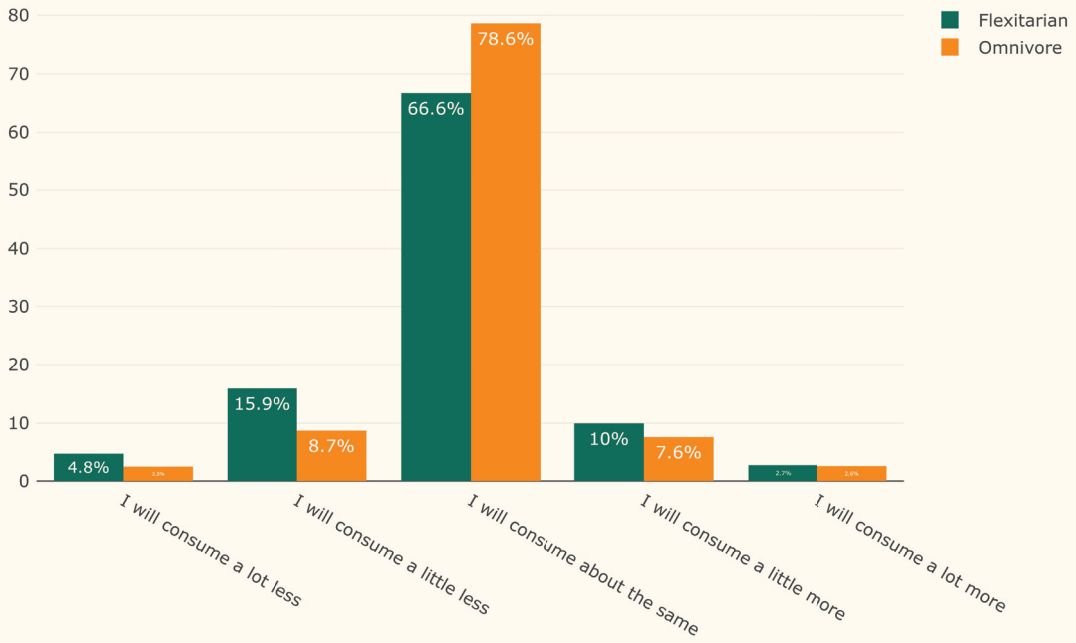
- 89% of omnivores indicated they will consume the same amount of dairy or more, while 12% reported they will consume a little or a lot less
- 80% of flexitarians indicated they will consume the same amount of dairy or more, while 21% reported they will consume a little or a lot less

DAIRY



*14. Do you intend increasing or reducing your consumption of **dairy products** (e.g., milk, yogurt, cheese, etc.) in the next 6 months?*

* Only asked to respondents that identified as omnivore or flexitarian


80
70
60
50
40
30
20
10
0
Flexitarian
Omnivore
4.8%
15.9%
66.6%
78.6%
10%
7.6%
I will consume a lot less
I will consume a little less
I will consume about the same
I will consume a little more
I will consume a lot more

15. By Diet

FREQUENCY OF CONSUMPTION

Dairy is the most frequently consumed food group

When asked to describe how frequently they consume 18 different food groups, dairy products stood out as the single most frequently consumed food group – 46% of respondents reported consuming dairy products once per day or more.

Fruits and vegetables follow in preference for most consumers

Fruits and vegetables were the next most frequently consumed food groups, followed by vegetable oils, then meat products – including (in order of frequency) processed meat products, red meat, poultry, and fish and seafood. Combined, 29% of respondents reported consuming meat products once per day or more, though 78% reported eating them 4-6 times per week or more.

Plant-based meat and dairy alternatives are the least frequently consumed foods

Plant-based meat and dairy alternatives (and tofu) were more than twice as likely to be reported as "never" consumed when compared to other all other food groups. "Plant-based cheese and tofu" was the least frequently consumed food group, with 46% of respondents saying they never consume these, followed by "plant-based milk alternatives" (40%), and "plant-based meat and poultry alternatives" (39%).

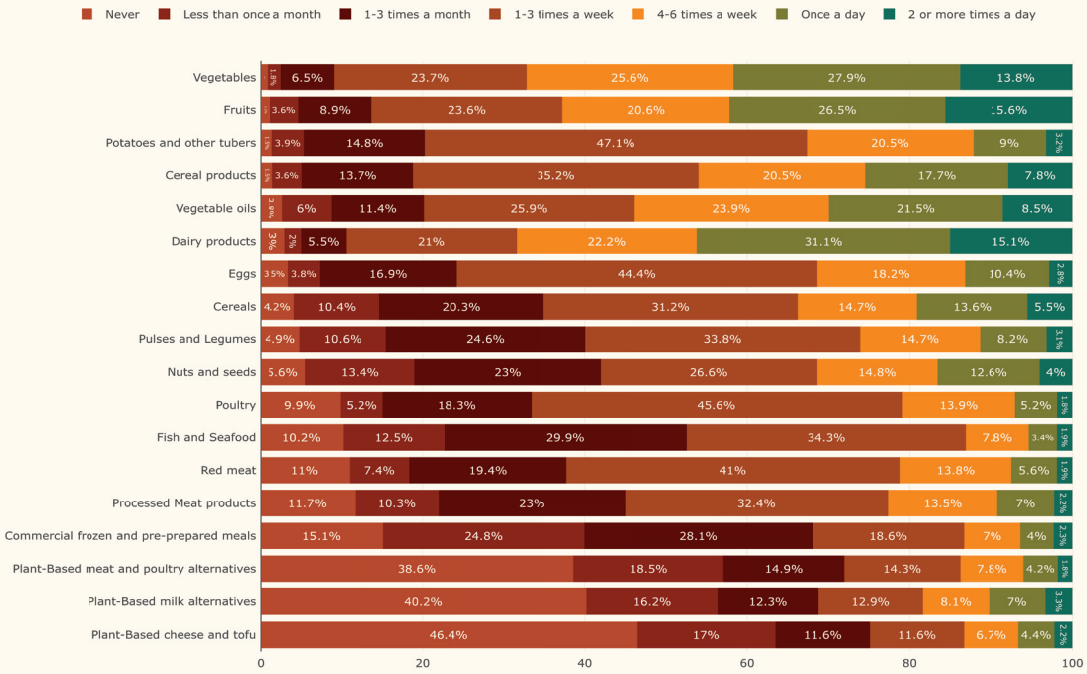
Moreover, dairy products stood out as the single most frequently consumed food group as 46% of respondents reported consuming them once or more daily.

Fruits and vegetables were the next most frequently consumed food groups, yet still far from complying with national dietary guidelines – 42% declare a daily serving of fruit and vegetables, and only 6% eat pulses daily. Fruits and vegetables were followed by vegetable oils, then meat products – including (in order of frequency) processed meat products, red meat, poultry, and fish and seafood. Combined, 29% of respondents reported consuming meat products once per day or more, though 78% reported eating them 4-6 times per week or more.

Plant-based milk alternatives show promise

Despite the low overall frequency of plant-based meat and dairy consumption when compared to other food groups, "plant-based milk alternatives" stood out – this food group was consumed once a day or more by 10% of respondents, possibly due to the rising availability of plant milks in foodservice and retail. In contrast, "plant-based meat and poultry alternatives" were consumed once a day or more by just 6% of respondents, and "plant-based cheese and tofu" by only 7%.

ALL FOOD GROUPS



*16. Which statement best describes **how frequently** you have consumed the following foods in the last 12 months?*

Prompt notes

Before we continue to the next questions, we would like to give you a few food definitions that are important to know for this survey:

- Legumes are sources of Plant-Based protein, and include lentils, beans, soy, and chickpeas (dried, canned, frozen).
- Legume-Based foods are made solely from the seeds of legumes*, and include tofu, tempeh, falafel, hummus, and soy-based products.
- Plant-Based alternatives are products made solely from Plant-Based ingredients and are developed to resemble conventional animal-based foods such as meat or dairy. (Examples include soy burgers and soy milk).

Most plant-based fermented foods are unfamiliar to consumers

After a brief prompt explaining different types of fermented foods and the roles of microorganisms in their production, respondents were asked to indicate the frequency with which they consume 15 different plant-based fermented foods.

Market penetration is the extent to which a product is recognised and purchased. At an aggregated level, the plant-based fermented products with higher market penetration are sourdough bread (77%), salt-pickled (75%), vinegar-pickled (30%) vegetables, and soy sauce (64%).

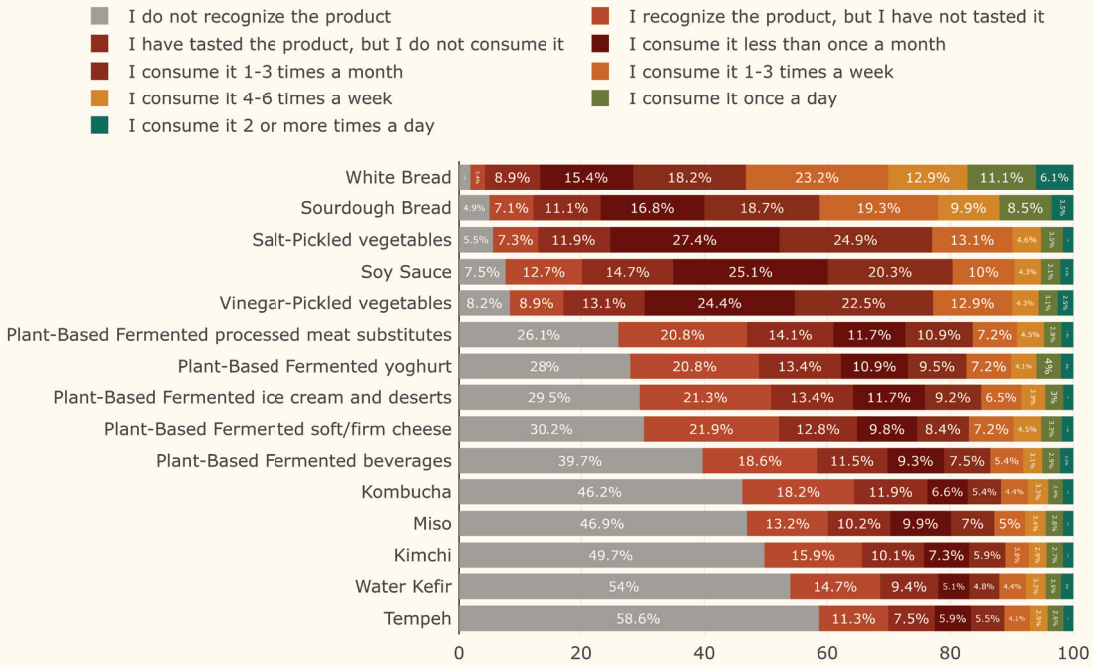
Among the remaining 10 products, familiarity was much lower, each with more than a quarter of respondents indicating they do not recognize the product. Tempeh was the least recognized plant-based fermented food product, with 59% reporting they do not recognize it and another 11% indicating they recognize but have not tasted it.

Plant-based fermented yogurt and cheese show promise

Despite low overall familiarity with plant-based fermented foods, plant-based fermented yogurt stood out – 11% of respondents reported consuming it 4-6 times per week or more, making it more likely than any of the other non-bread foods to be consumed with such frequency.

Vinegar, salt pickles, and plant-based cheese followed, with nearly 10% of respondents indicating consumption at least 4-6 times per week.

Although low recognition remains a challenge for such products, these figures highlight the potential of plant-based fermented yogurt and cheese as foods consumers may incorporate with relatively high frequency in their diets.



17. Please indicate how often do you consume the following ***fermented products***

For the purpose of this questionnaire, Fermented Foods are defined as "foods made through desired microbial growth and enzymatic conversions of food components". Fermented Foods are produced from diverse food substrates, such as vegetables, grains, soybean, milk, fish and meat. Fermented Foods often contain live microorganisms. Among those foods are yogurt, cheese and kombucha. However, in several Fermented Foods the microorganisms are not alive anymore, for example in bread, pasteurised fermented vegetables, soy sauce, and wine.

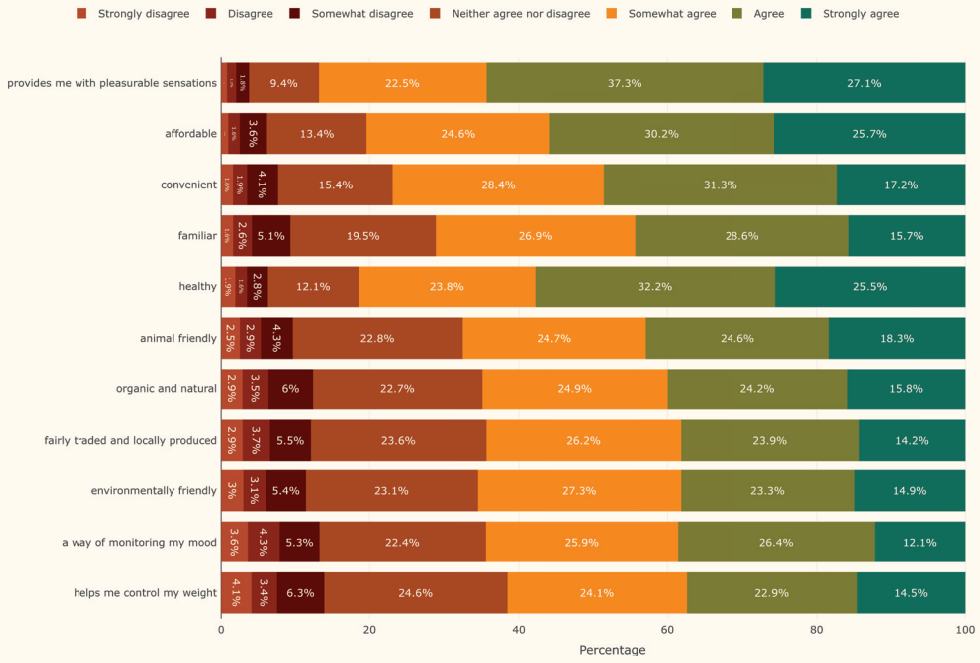
The products made from plants (fruits, vegetables, nuts, seeds, whole grains, legumes, beans, etc.) will be referred as "Plant-Based Food", while the products made from fermentation on Plant-Based plant-based raw materials will be referred as "Plant-Based Fermented Food".

Please indicate (with a cross or tick) how often do you consume the following fermented products present in the table, on a scale from "I do not recognize the product" to "I consume it 2 or more times a day"

PERCEPTIONS, MOTIVES, AND BARRIERS

FOOD CHOICE MOTIVES

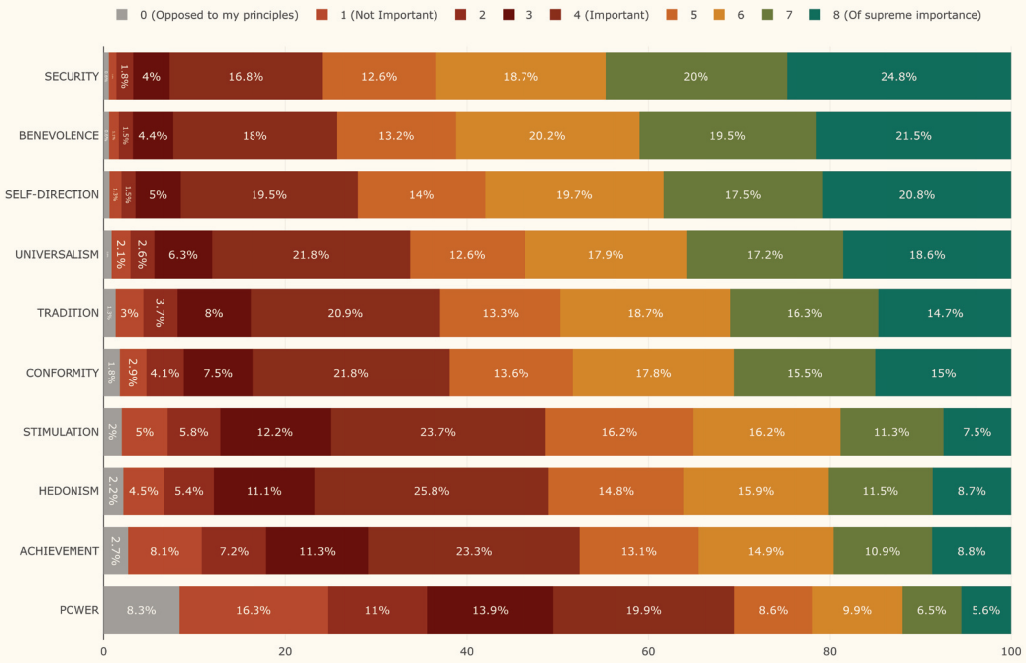
The most important food choice motive among the respondents remains the pleasurable sensory experience (87%). It is followed by its perceived healthiness (81%), its affordability (80%), convenience (%) and familiarity (71%). It therefore suggests a more self-centered motivation. Altruist and environmental motives, although important are less prominent.



*18. It is **important to me** that the food I eat on a typical day is*

VALUES

The value being considered as of "Supreme importance" by the sample is "Security" (25%). This might be related to current geopolitical conflicts and environmental catastrophes that are taking place in the EU or vicinity. 'Benevolence' and 'self-direction' (22% and 21% respectively) were the second and third most important values. 'Power' has the least importance to the respondents (6%).



*19. Please, rate the importance of the following values as a **life-guiding principle** for you*

POWER (social power, authority, wealth)

ACHIEVEMENT (success, capability, ambition, influence on people and events)

HEDONISM (gratification of desires, enjoyment in life, self-indulgence)

STIMULATION (daring, a varied and challenging life, an exciting life)

SELF-DIRECTION (creativity, freedom, curiosity, independence, choosing one's own goals)

UNIVERSALISM (broad-mindedness, beauty of nature and arts, social justice, a world at peace, equality, wisdom, unity with nature, environmental protection)

BENEVOLENCE (helpfulness, honesty, forgiveness, loyalty, responsibility)

TRADITION (respect for tradition, humbleness, accepting one's portion in life, devotion, modesty)

CONFORMITY (obedience, honoring parents and elders, self-discipline, politeness)

SECURITY (national security, family security, social order, cleanliness, reciprocation of favors)

ATTITUDES & FAMILIARITY

Consumers expect clean labels for fermented plant-based food products

When asked to evaluate a number of statements regarding attitudes and familiarity related to plant-based fermented foods, the importance of clean label products topped the list. Organic/bio certification also showed strong importance, and respondents showed high levels of agreement with statements about the positive impacts of plant-based fermented foods on environmental sustainability.

Consumers are unsure about health and sustainability benefits

47% of respondents agreed that "fermented plant-based foods facilitate a sustainable and healthy dietary transition," with just 20% expressing disagreement. However, when assessing the statement "plant-based fermented foods contribute positively to my health state," only 35% agreed while 28% disagreed.

Similarly, when compared with plant-based foods that are not necessarily fermented, respondents did not believe fermented plant-based foods were more healthy or sustainable – agreement was actually slightly lower for the statement that specified "fermented."

This uncertainty around the health and sustainability benefits of plant-based fermented foods may indicate a general lack of familiarity, as the statement "plant-based fermented foods are novel to me" received the second highest level of agreement among all questions in this section of the survey.

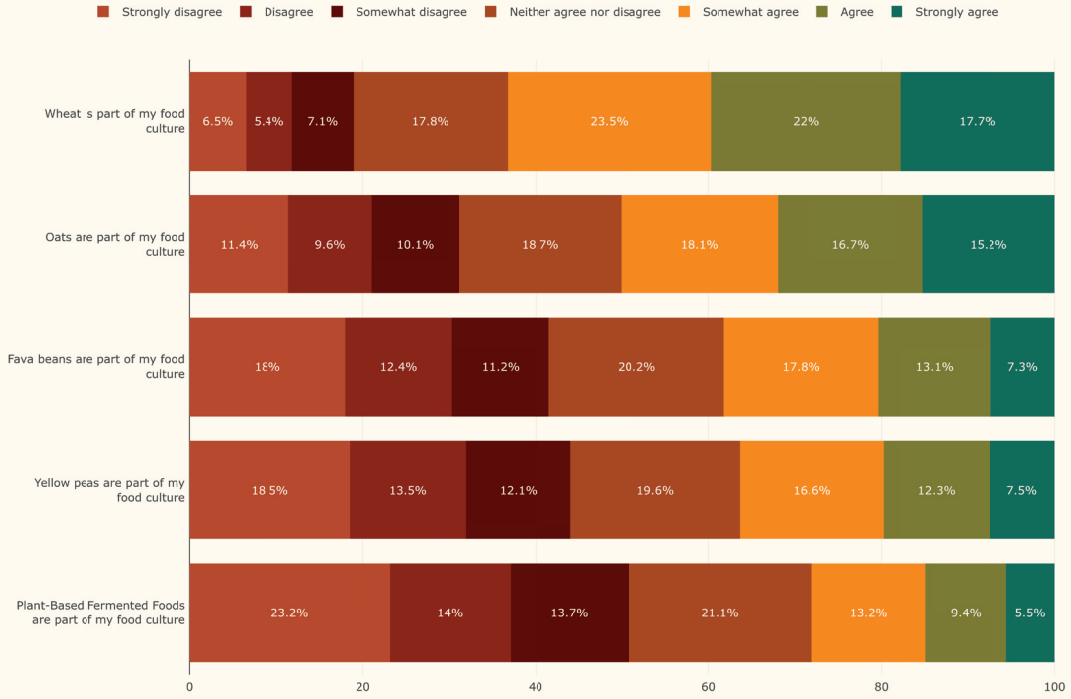
Affordability and availability of plant-based foods are perceived to be low

When asked to evaluate a series of statements regarding plant-based foods (not necessarily fermented), affordability and availability stood out. The statement "plant-based foods are affordable and available in grocery shops and foodservice" received the highest levels of disagreement and the lowest levels of agreement among all statements in this section.

Some consumers do not know how to prepare or include plant-based foods in their diet

Statements regarding the ease of including more plant-based foods in one's diet and knowing how to prepare a meal that includes plant-based foods both showed high levels of agreement when compared to other statements in this section. However, responses were somewhat polarized – they also showed high levels of disagreement, indicating that familiarity with how to prepare and consume plant-based foods may be a significant barrier for some groups.

FOOD CULTURE



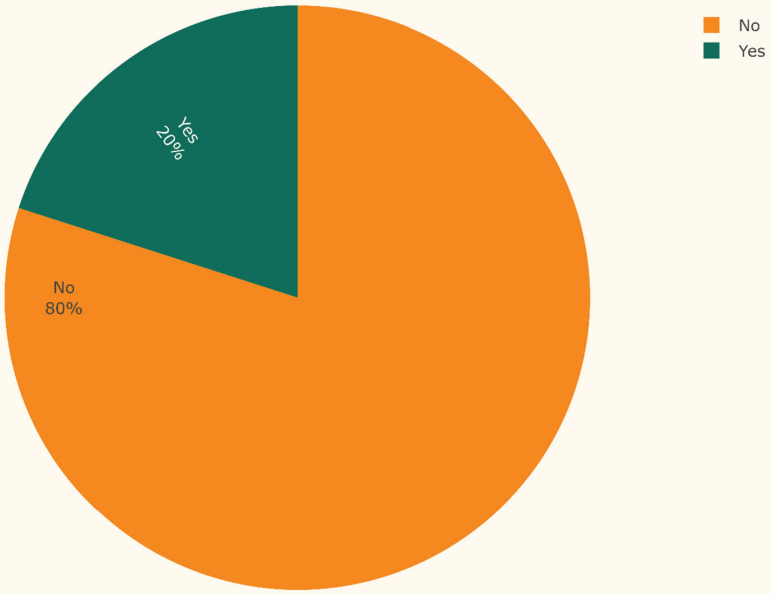
20. Please evaluate the following statements

During the evaluation, please take into account that food culture represents habits, rituals, values, lifestyle and traditions focused in food. Family history, heritage, ethnicities, geographical, climate, social and political contexts greatly influence the person's food culture.

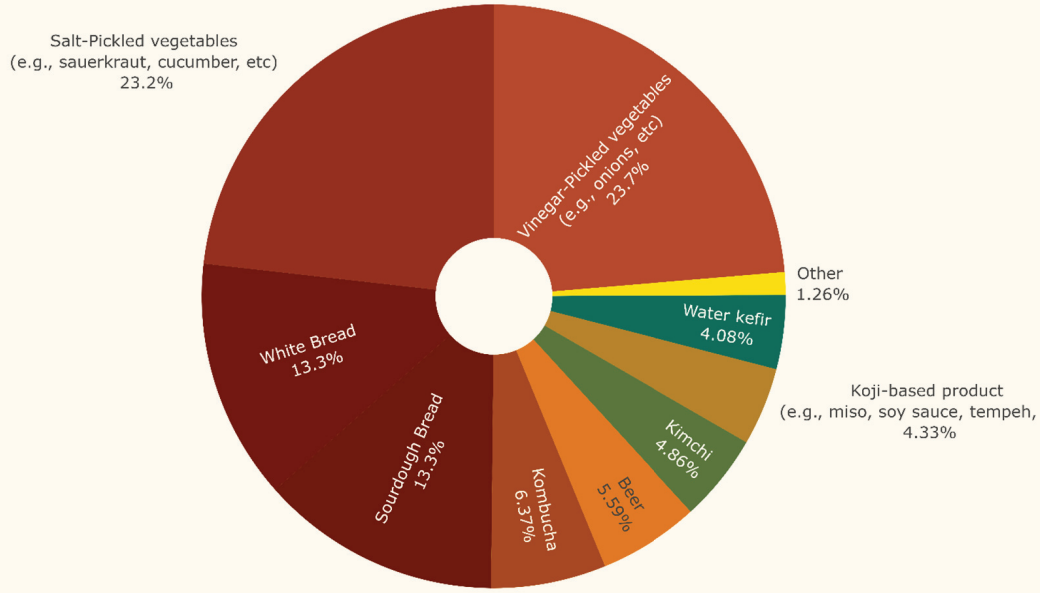
FERMENTATION ACTIVITY

20% of the respondents state that they are actively involved in preparing home fermentations.

The most encountered plant-based fermented products are Vinegar- and Salt-pickled vegetables, followed by White and Sourdough bread and finally Kombucha.



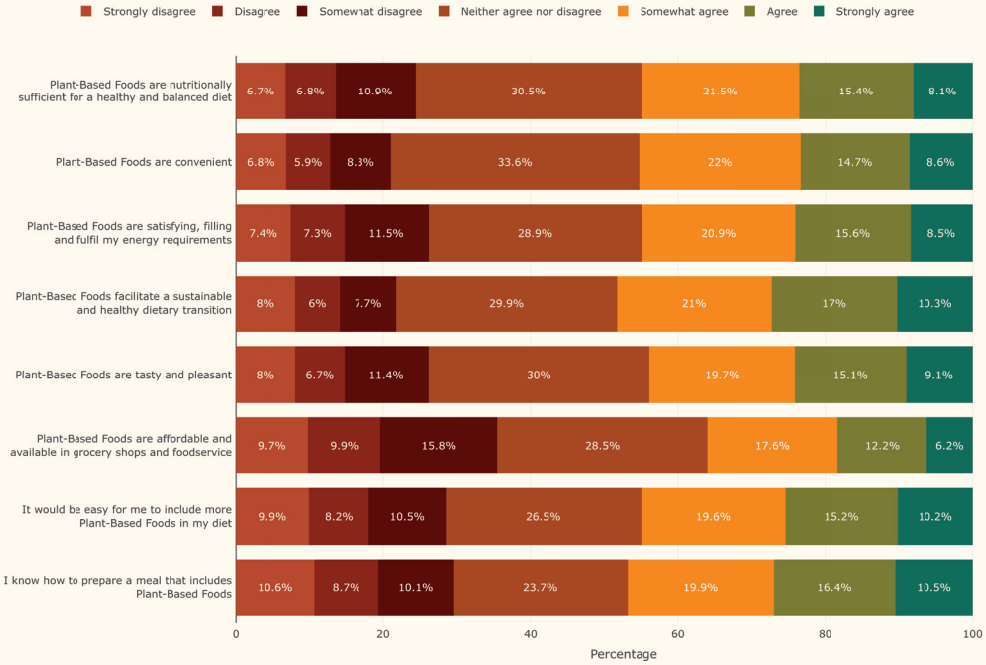
21. Do you ferment?



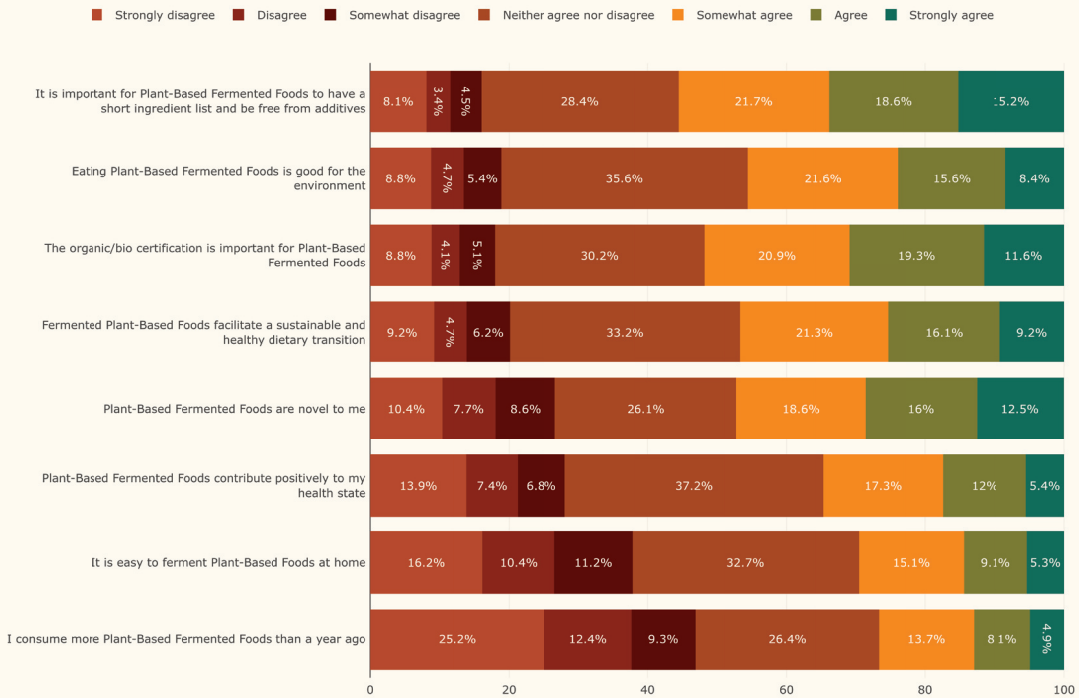
22. What kind of product(s) do you ferment?

ATTITUDES

EU citizens show a general positive attitude towards plant-based foods in general and their fermented products in particular. Both are further considered as facilitating a sustainable and healthy dietary transition. Plant-based fermented foods are perceived as environmentally friendly, and it is important that they have a short ingredient list and free from additives.



23. Please evaluate the following statements about your attitudes towards ***Plant-Based Foods***



24. Please evaluate the following statements about your attitudes towards ***Plant-Based Fermented Foods***

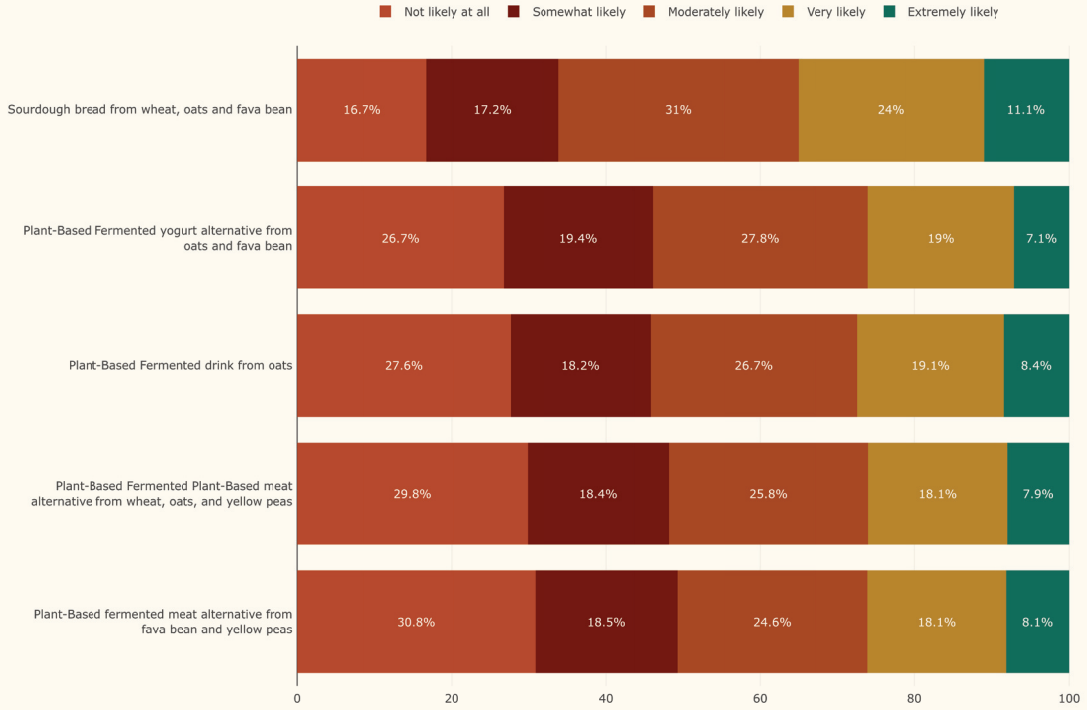
RAW MATERIALS

Low familiarity with fava bean and yellow peas

Respondents showed overall high familiarity with the four raw materials on which HealthFerm research is primarily focused: wheat, oats, fava beans, and yellow peas. However, wheat and oats were much more likely to be recognized and consumed by respondents than fava beans and oats.

Similarly, wheat and oats were much more likely to be identified as part of respondents' food culture than fava beans and yellow peas.

LIKELIHOOD TO TRY



25. Imagine the following products are available on the market. How likely are you to try them?

TRUST

Precision fermentation in the spotlight

When asked to evaluate 11 statements regarding their trust in plant-based fermented foods, respondents surprisingly expressed the highest levels of trust, and the lowest levels of distrust, toward the processes involved in precision fermentation.

Both traditional and biomass fermentation ranked lower in trust levels than precision fermentation, indicating a need for more research into how consumers understand and feel about fermentation technologies.

Overall trust levels are high

However, despite these unexpected findings, overall trust in fermentation was high – respondents were more than twice as likely to agree than disagree with a broad range of statements regarding fermentation processes, technology, quality, authenticity, companies, labelling, safety, traceability, and consistency of products.

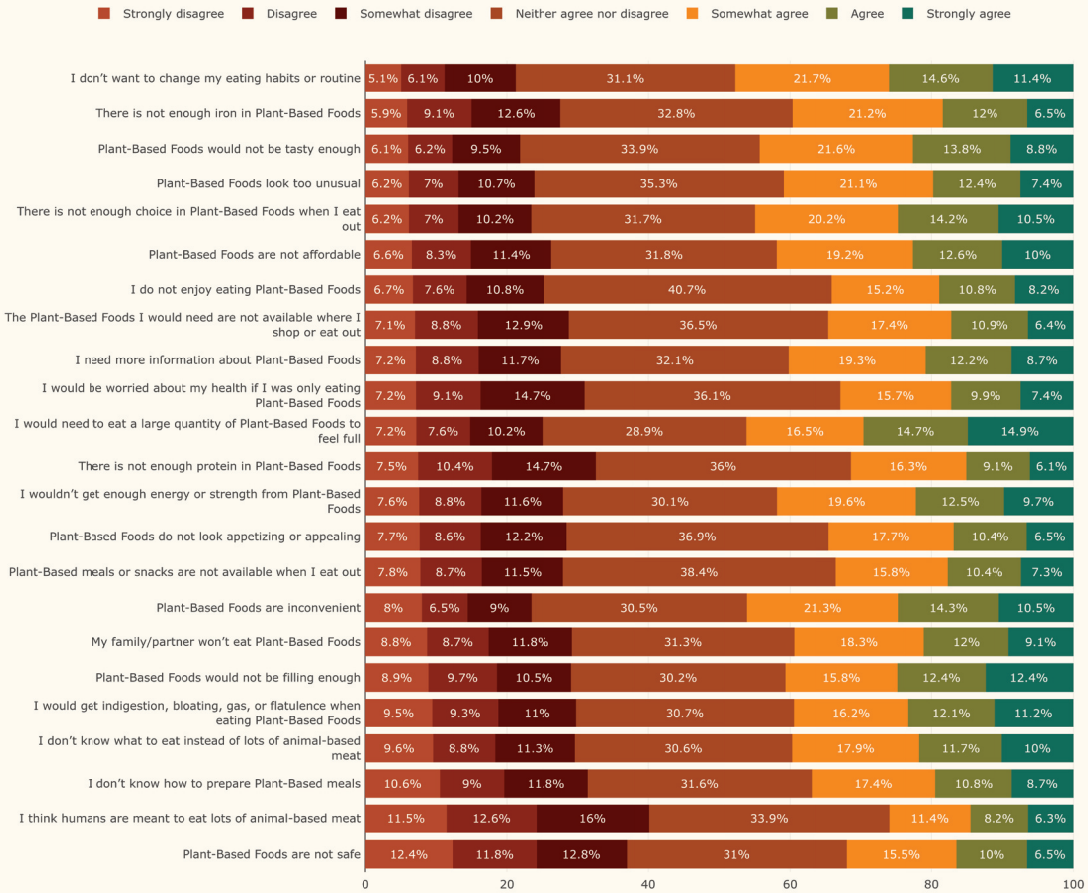
26. Please evaluate the following statements about your trust towards ***Plant-Based Fermented Foods***

BARRIERS

Multiple barriers to plant-based food consumption

Respondents were presented with 23 statements representing possible barriers toward plant-based food consumption. Among these, five stood out as most significant:

1. "I don't want to change my eating habits or routine" – 48% agree, 21% disagree
2. "I would need to eat a large quantity of plant-based foods to feel full" – 46% agree, 25% disagree
3. "Plant-based foods are inconvenient" – 46% agree, 24% disagree
4. "There is not enough choice in plant-based foods when I eat out" – 45% agree, 23 disagree
5. "Plant-based foods would not be tasty enough" – 44% agree, 22% disagree



27. Please evaluate the following statements about your barriers towards **Plant-Based Foods** *consumption*

INTENTIONS

Consumers are curious but not committed to plant-based fermented foods

When asked to indicate their intentions about incorporating plant-based fermented foods into their diets, respondents expressed curiosity, and to a slightly lesser degree, plans to seek out new plant-based fermented foods to try.

However, respondents were more ambivalent when asked whether they are considering to increase their consumption of plant-based fermented foods in the near future, with 35% agreeing vs. 37% disagreeing.

Fewer respondents were committed to regularly consuming plant-based fermented foods, with 33% agreeing compared to 41% disagreeing.

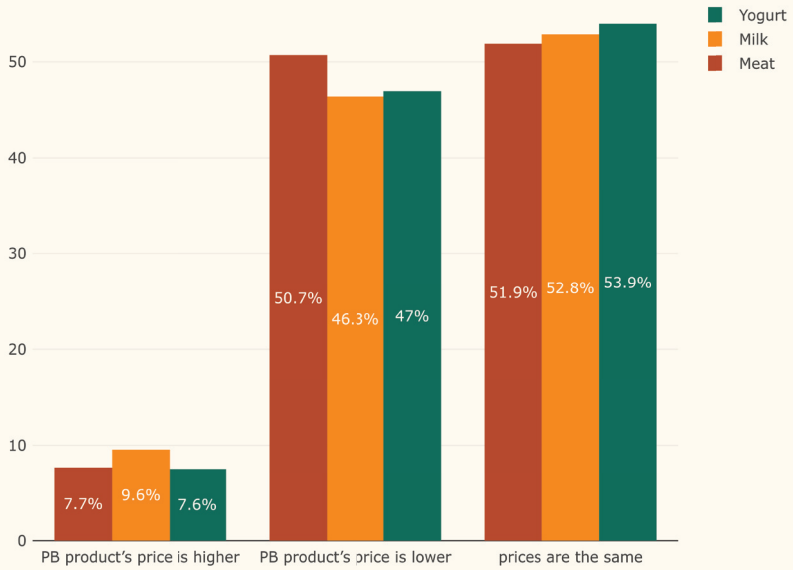
*28. Please evaluate the following statements about **Plant-Based Fermented Foods***

MARKET OPPORTUNITIES

PLANT-BASED FERMENTED PRODUCTS

Price matters, but lower is not always better

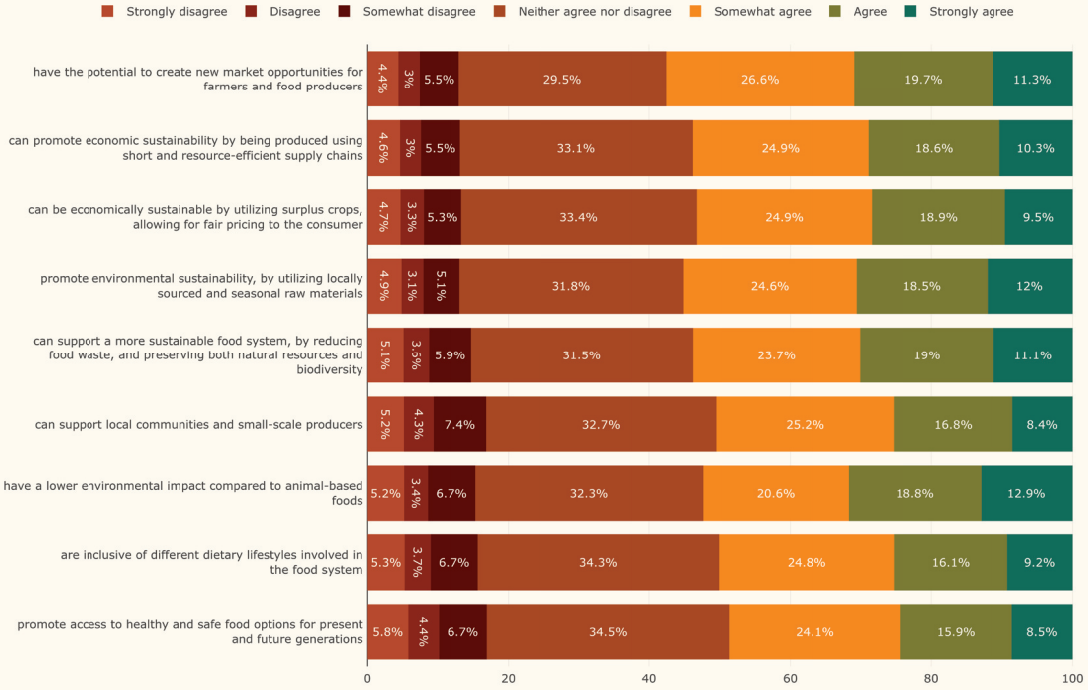
Consumers may be more willing to purchase a fermented plant-based meat, milk, or yogurt alternative when its price is the same as its animal-based counterpart than if its price is lower. Surprisingly, this is what respondents reported when asked under which price conditions they would purchase a fermented plant-based product. If such a meat, milk, or yogurt alternative were priced lower than its animal-based counterpart, respondents indicated a slightly lower likelihood of purchasing.



*29. In which price condition (comparing to animal-sourced foods) would you buy the following **fermented plant-based alternatives**, that are optimized for taste, health and sustainability (multiple choice is allowed)?*

SUSTAINABILITY

The scale of social, environmental and economic importance of PBFF consists of 9 items, three for each category, social, economic and environmental roles of fermented foods. 58% of respondents at least somewhat agree that PBFF have the potential to create new market opportunities. 13% strongly agree that PBFF have a lower environmental impact compared to animal foods. The statement with which the respondents disagree the most with ('somewhat disagree', 'disagree', 'strongly disagree') is the one stating that the production and consumption of PBFF can support local communities and small-scale producers (17%).



*30. Please evaluate the following statements about the role that **Plant-Based Fermented Foods** may have on social, environmental and economic **sustainability***

Consumers prefer ingredient blends over yellow pea and fava bean-based products

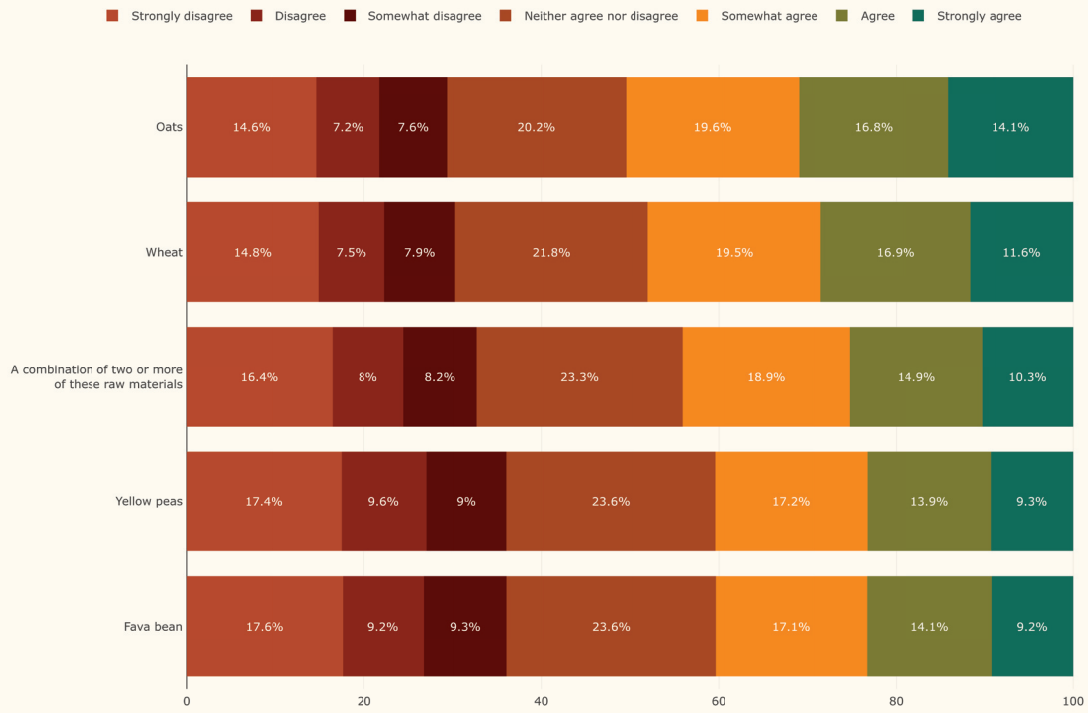
Consumers are more willing to try plant-based fermented drinks, yogurt alternatives, meat alternatives, and protein-enriched breads made from oats and wheat than from yellow peas or fava beans – the four raw materials on which HealthFerm research is primarily focused.

This may be explained by low familiarity with yellow peas and fava beans, as well as low association with respondent food culture. However, interestingly, respondents expressed willingness to try products made from two or more of these four ingredients with higher preference than for yellow pea or fava bean-based products alone, indicating potential for ingredient blends.

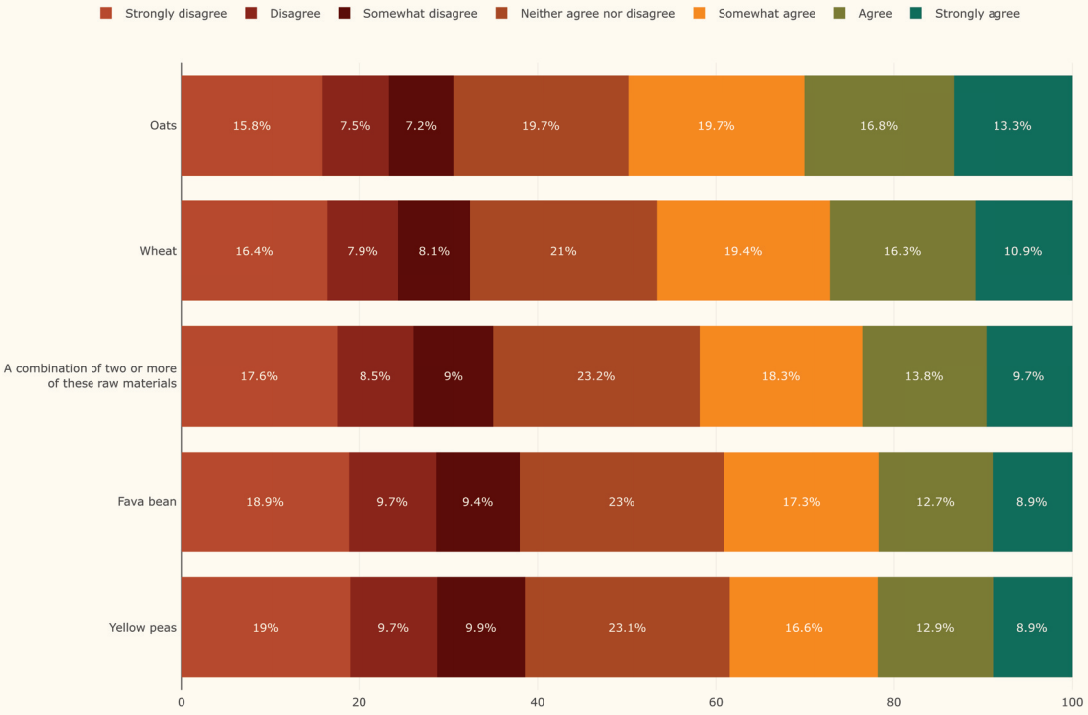
More willingness to try meat alternatives made with yellow peas and fava beans

Although preferences for ingredients ranked similarly across each product, their differences were less pronounced for plant-based fermented meat alternatives – respondents indicated similar willingness to try plant-based fermented meat products made from each ingredient.

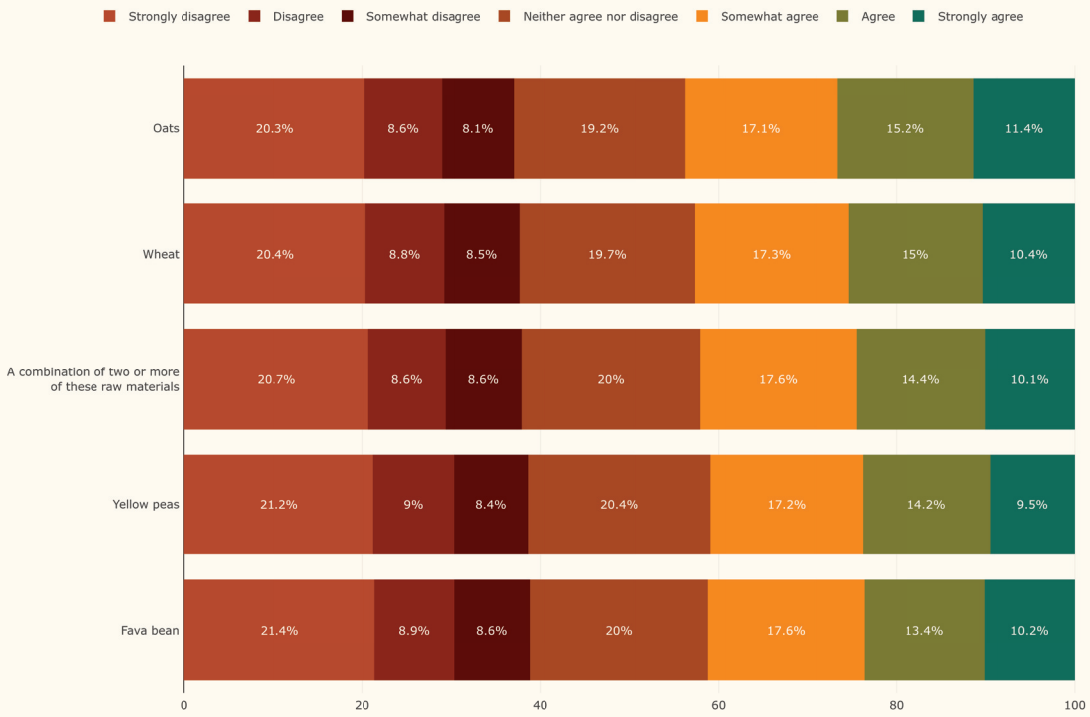
This may be because grains are increasingly associated with modern dairy alternatives while beans and peas are frequently associated with meat alternatives. Although further investigation is needed to understand this difference, these findings could prove useful for product formulators and marketers.



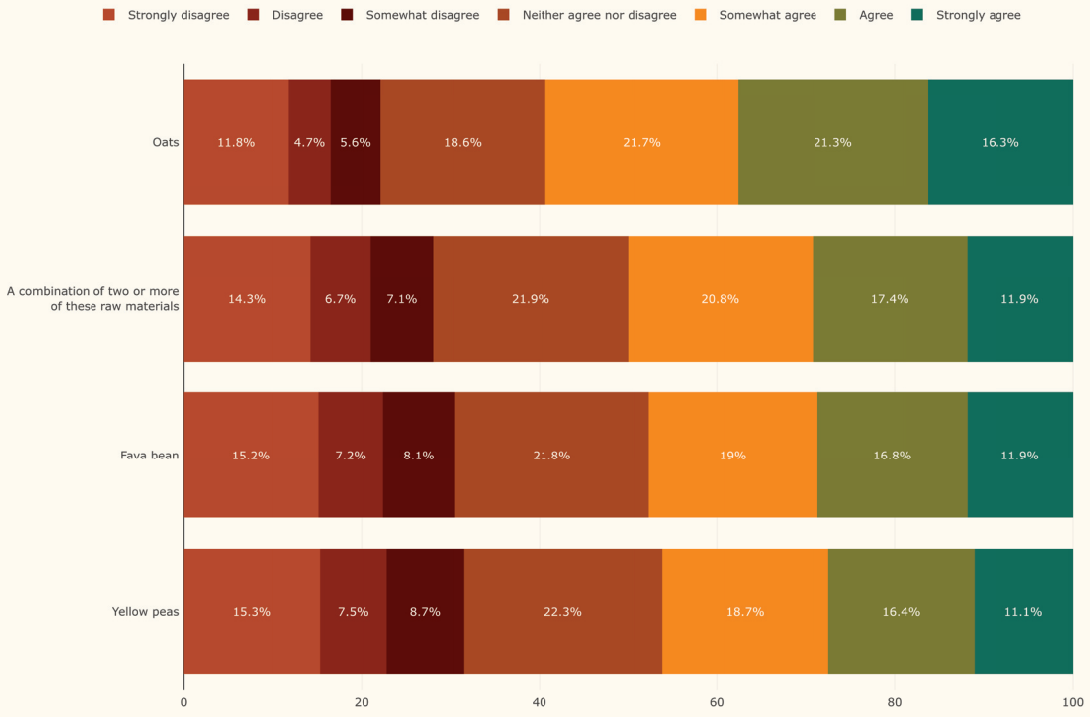
*31. I would be willing to try a **Plant-Based Fermented drink** made from*



*32. I would be willing to try a **Plant-Based Fermented yogurt alternative** made from*



*33. I would be willing to try a **Plant-Based Fermented meat alternative** made from*



*34. I would be willing to try a **Plant-Based Fermented protein-enriched bread** made from*

TECHNOLOGIES

Consumers are generally open to trying products prepared through different fermentation technologies

Following a detailed prompt explaining the differences between traditional, biomass, and precision fermentation, respondents expressed high overall willingness to try products prepared using each technology.

Across each fermentation category, respondents were more than twice as likely to agree than disagree with statements regarding their willingness to try products.

Traditional fermentation is favored over biomass and precision fermentation

Although precision and biomass fermentation showed similar levels of acceptance, 61% of respondents favored traditional fermentation, and about half of the respondents indicated willingness to try products prepared through precision or biomass fermentation.

Precision fermentation is slightly favored over biomass fermentation

Although precision and biomass fermentation showed similar levels of acceptance, respondents slightly favored precision fermentation – 52% indicated willingness to try products prepared through precision fermentation, compared to 49% for biomass fermentation.

Similarly, fewer respondents were unwilling to try products prepared through precision fermentation than biomass fermentation – 23% compared to 23%, respectively.

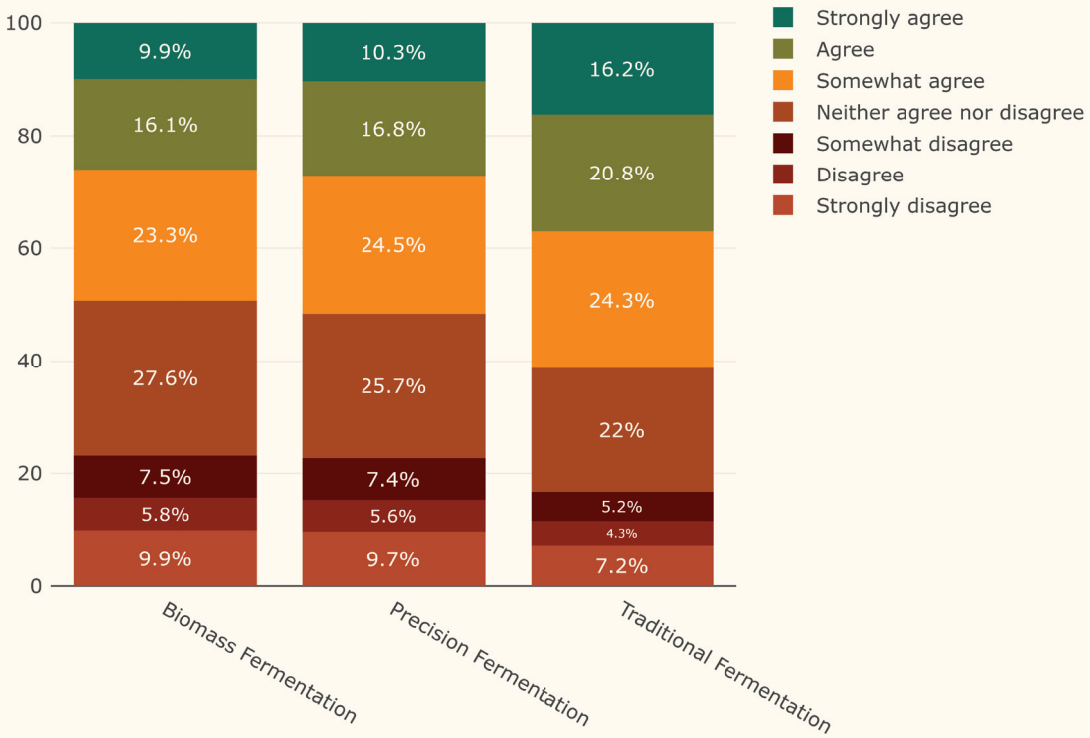
Omnivores are least willing to try plant-based fermented foods

Despite having the least restrictive dietary lifestyle, omnivores expressed significantly lower willingness to try products prepared through fermentation across all technologies.

Willingness to try plant-based fermented foods mostly showed an inverse relationship with the levels of animal products in respondent diets – those consuming fewer types of animal products were generally more willing to try products prepared through all three fermentation categories. One exception was respondents that identified as pescatarian, who were slightly more open to all three categories than those who identified as vegetarian.

Rankings of willingness to try across fermentation categories also showed some differences by diet. In contrast to all other dietary lifestyles, respondents that identified as vegetarian or vegan both slightly favored biomass over precision fermentation.

WILLINGESS TO TRY



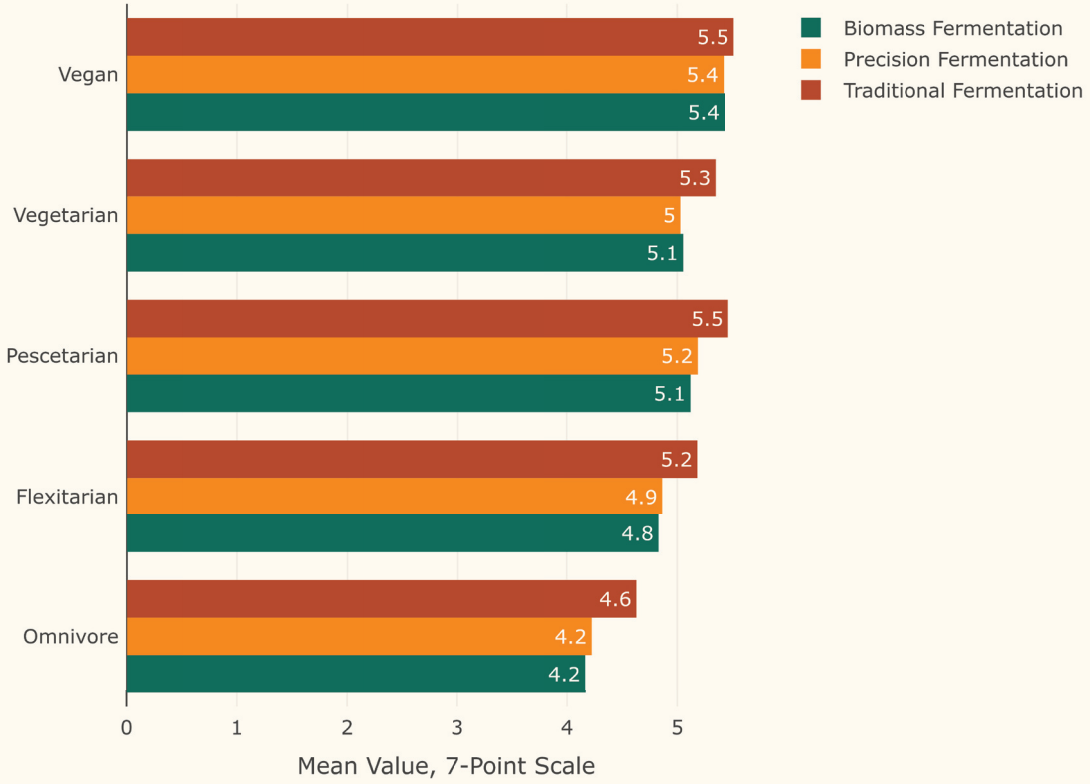
35. I would be willing to try a product that is prepared through...

Please evaluate the following statements about your attitudes towards Plant-Based Fermented Foods. Prior to evaluation, please read through the following definitions:

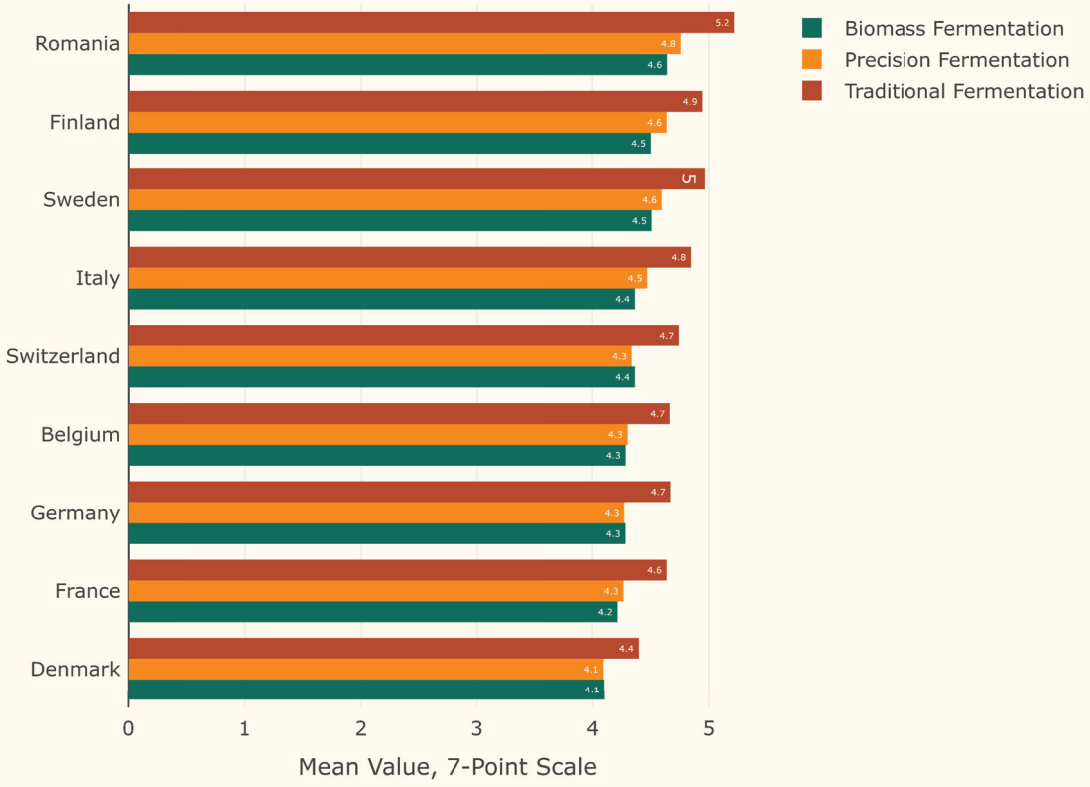
Traditional Fermentation is the process of modifying food via **microbial activity**. This is how beer, wine, yogurt, and cheese are made. Traditional fermentation is used e.g. to **improve the flavor** or **functionality** of plant ingredients.

Biomass Fermentation is utilized within food industry to grow **protein-rich microorganisms**. These microorganisms are used as ingredients for plant-based alternative proteins. Alternative proteins are aimed to replace milk, meat, or fish as protein source. For example, filamentous fungi grown via fermentation can be used as the primary ingredient of alternative protein.

Precision Fermentation uses microorganisms to produce specific functional ingredients. The microorganisms are programmed to be little production factories. This is how insulin for diabetic patients is produced, as well as rennet for cheese production. Precision fermentation enables alternative protein producers to efficiently make specific proteins, enzymes, flavor molecules, vitamins, pigments, and fats.



36. By Diet



37. By Country

Significant differences across countries on willingness to try plant-based fermented foods

Romania topped the chart on willingness to try products prepared through all three fermentation categories. Additionally, Romania was the only country whose respondents had a mean score greater than five for willingness to try traditional fermentation products, using the seven-point scale from which respondents selected. While further investigation is needed to understand this finding, it may related to the already high level of traditionally fermented vegetables and dairy products in typical Romanian diets.

At the other end of the spectrum, respondents from Denmark expressed the lowest willingness to try products prepared through all categories of fermentation.

Respondents from all nine countries clearly favored traditional fermentation over other fermentation categories, and most countries favored precision over biomass fermentation. However, Switzerland, Germany, and Denmark diverged from this trend, with their respondents slightly favoring biomass over precision fermentation.

Older consumers are less willing to trying plant-based fermented foods

Excluding the youngest age group of 18–24-year-olds, willingness to try products across all fermentation categories decreased significantly with respondent age. Those in the 25-34 age group expressed the highest willingness to try products from all fermentation categories, while those in the 65+ age group expressed the lowest willingness.

Interestingly, relative willingness to try products of biomass and precision fermentation varied somewhat differently with age – within the 18-24, 25-34, and 35-44 age groups, biomass was slightly favored over precision fermentation, with the difference decreasing with age to reach parity in the 35-44 group. For all older age groups, the preference is reversed, with respondents favoring precision over biomass fermentation to an increasing degree with age.

Consumers with higher education levels and socioeconomic statuses are more willing to try plant-based fermented foods

Willingness to try foods prepared through traditional, biomass, and precision fermentation all showed a positive relationship with education level and socioeconomic status, metrics that are typically expected to be highly correlated.

Among all education levels, traditional fermentation was favored significantly over other fermentation categories. However, only respondents with a graduate degree or higher slightly favored biomass over precision fermentation, while others clearly favored precision over biomass fermentation.

Interestingly, in contrast to all other socioeconomic status groupings, respondents that indicated their financial situation is "extremely easy" expressed similar willingness to try products from all three fermentation categories, with only a slight preference for traditional fermentation – all other socioeconomic, dietary, geographic, age, and education groupings show strong preferences for traditional over other categories of fermentation.

It was also noteworthy that among all socioeconomic status groupings, only respondents who described their financial situation as "extremely easy" and "extremely difficult" slightly favored biomass over precision fermentation, while all others preferred precision over biomass fermentation.

SENSORY PREFERENCES

Respondents were asked to indicate their preferences for key sensory characteristics that would be present in four different products on which HealthFerm researchers are focused: drinkable yogurt, yogurt, chicken alternative, and protein-enriched bread. For each sensory modality – appearance, odour, taste/flavour, texture/mouthfeel – multiple attributes were presented from which multiple selections could be made.

The findings are presented in a series of charts for each product, which may be used by product developers, marketers, and other researchers to support evidence-based strategies toward maximizing consumer appeal and acceptance.

DRINKABLE YOGURT & YOGURT

Color and uniformity are important for appearance

For both fermented plant-based drinkable yogurt and yogurt products, "liquid," "white colour," and "uniform" were the top-three most selected as desirable appearance attributes, while "thick" was also of significant importance for yogurt.

Colour preferences were also unambiguous – "white colour" was among the most important appearance characteristics respondents, while "light yellow colour" and "light brown colour" were much less desirable.

Sweetness is key for odour and flavour

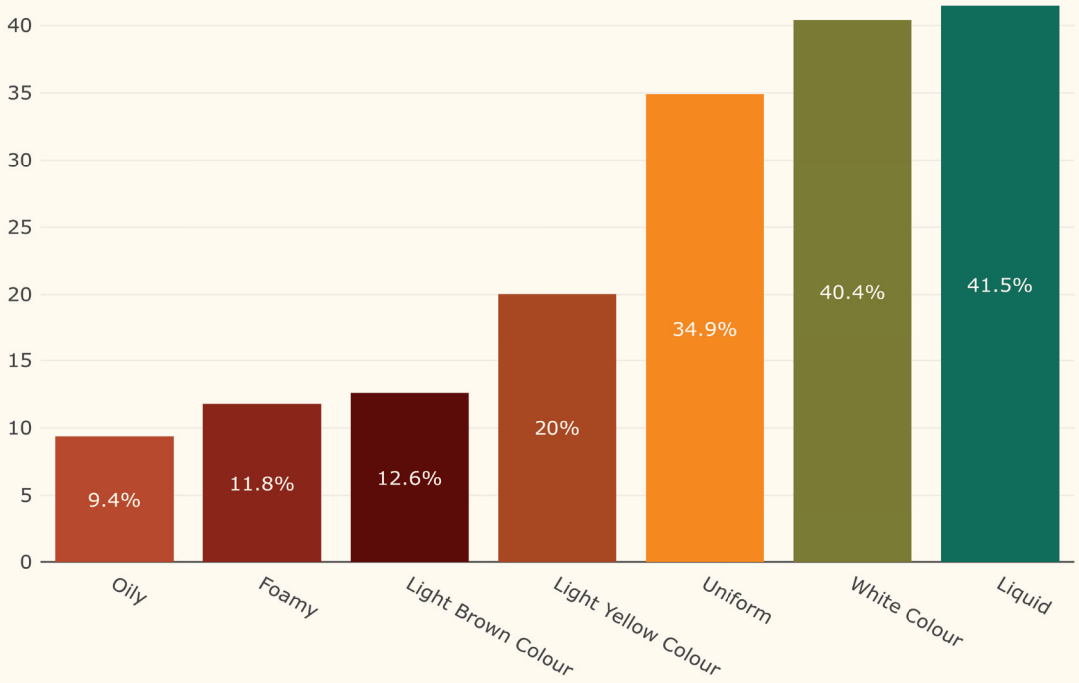
"Sweet" was the most desirable flavour attribute selected by respondents. Interestingly, "grain (as in oat, wheat and rye)" was the next most desirable and flavor and odour characteristic for both products. In contrast, "beany" was clearly undesirable for both sensory modalities.

Creaminess is king for texture

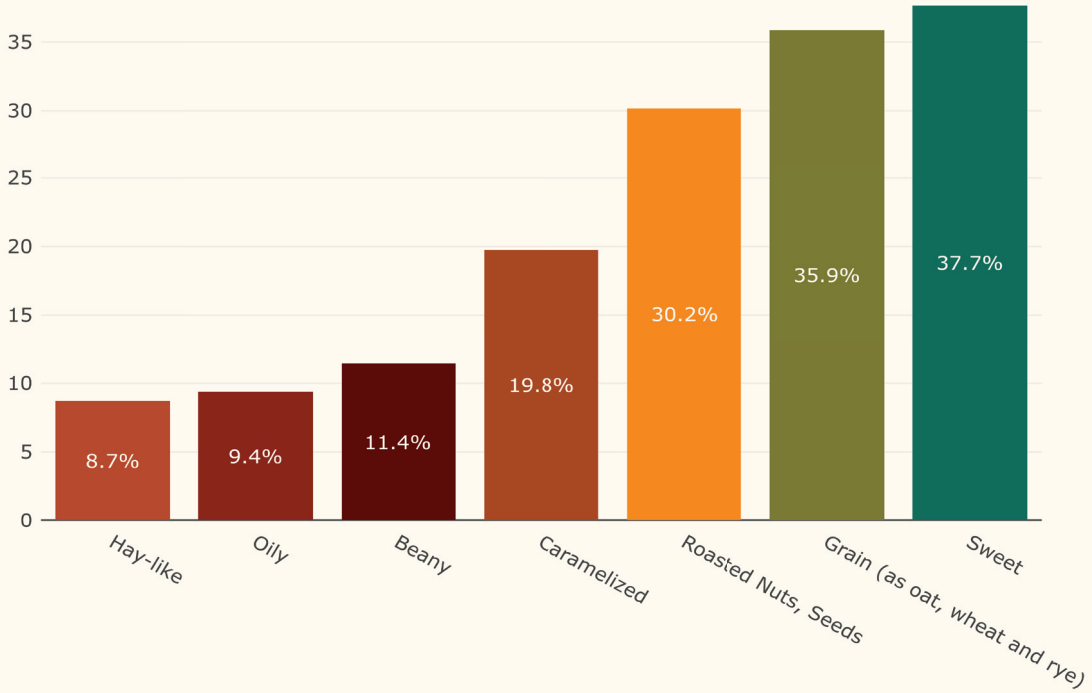
Fermented plant-based drinkable yogurt and yogurt products must have "creamy" textures. Respondents selected this attribute as most desirable for both products, while "thick," "smooth," "liquid," and "uniform" were also key characteristics for texture.

For fermented plant-based yogurt, respondents indicated "gel-like" was significantly less desirable for both appearance and texture, indicating a need for thickening techniques that avoid this outcome.

These findings indicate that while consumers desire some grainy and nutty flavours and aromas, they largely want fermented plant-based yogurts and drinkable yogurts to have the white, creamy, uniform, and sweet characteristics they expect from dairy-based products.

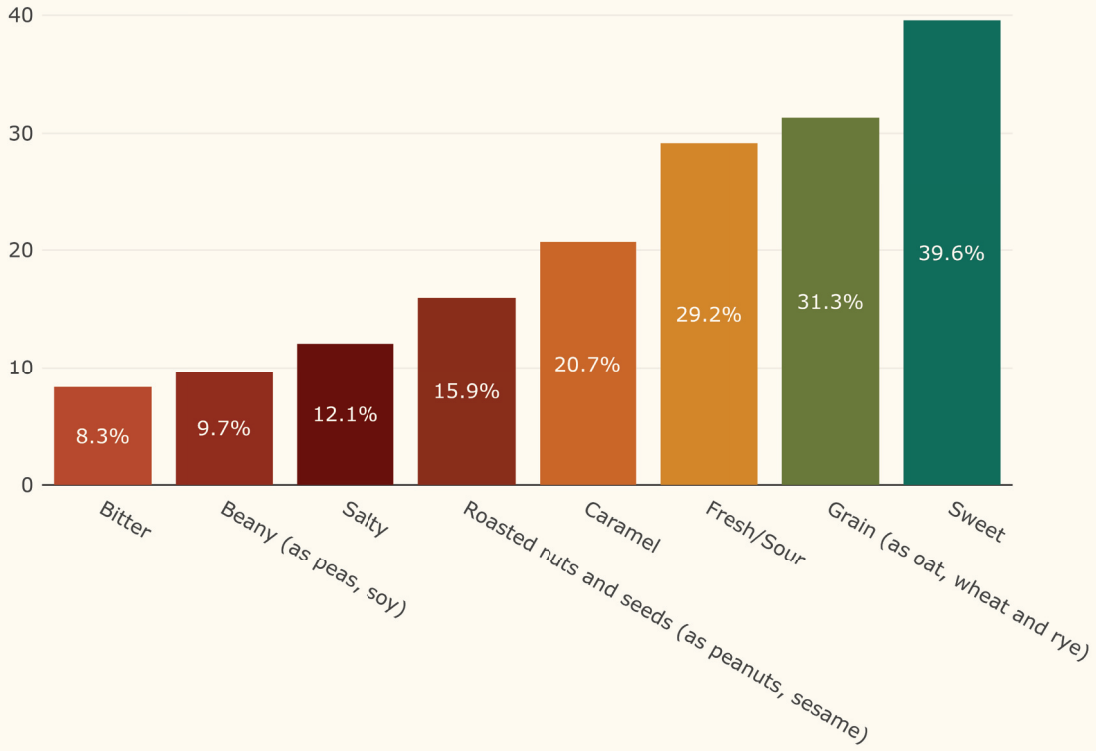


38. Appearance

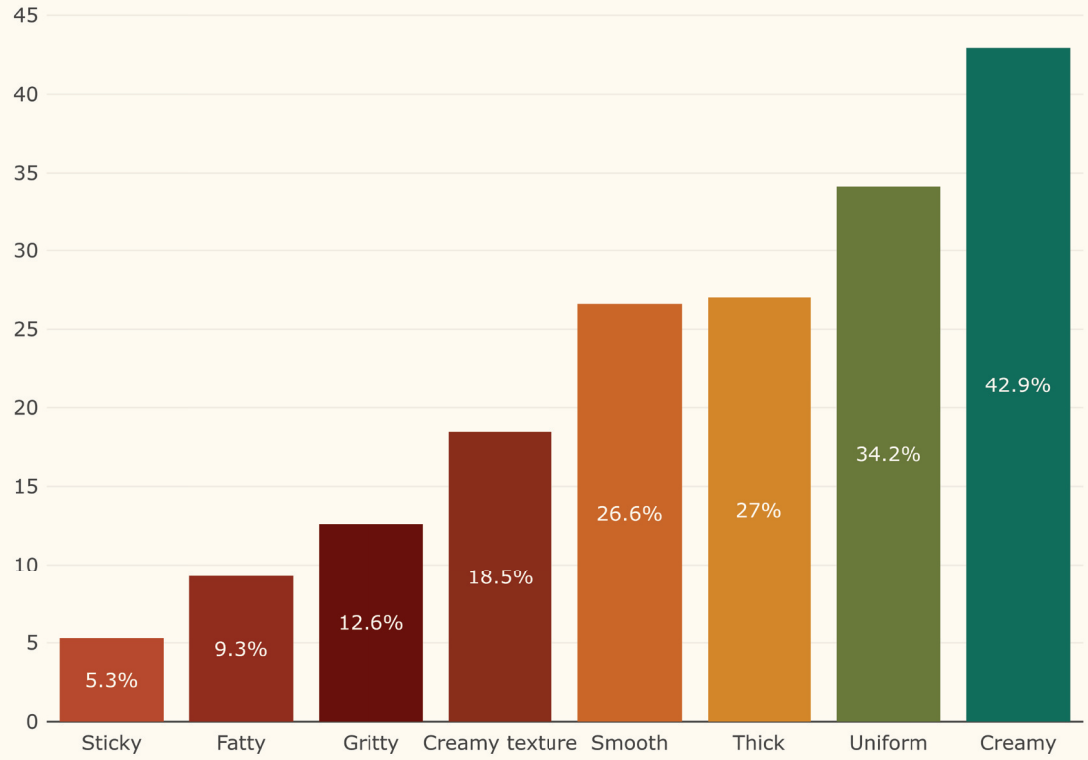


39. Odour

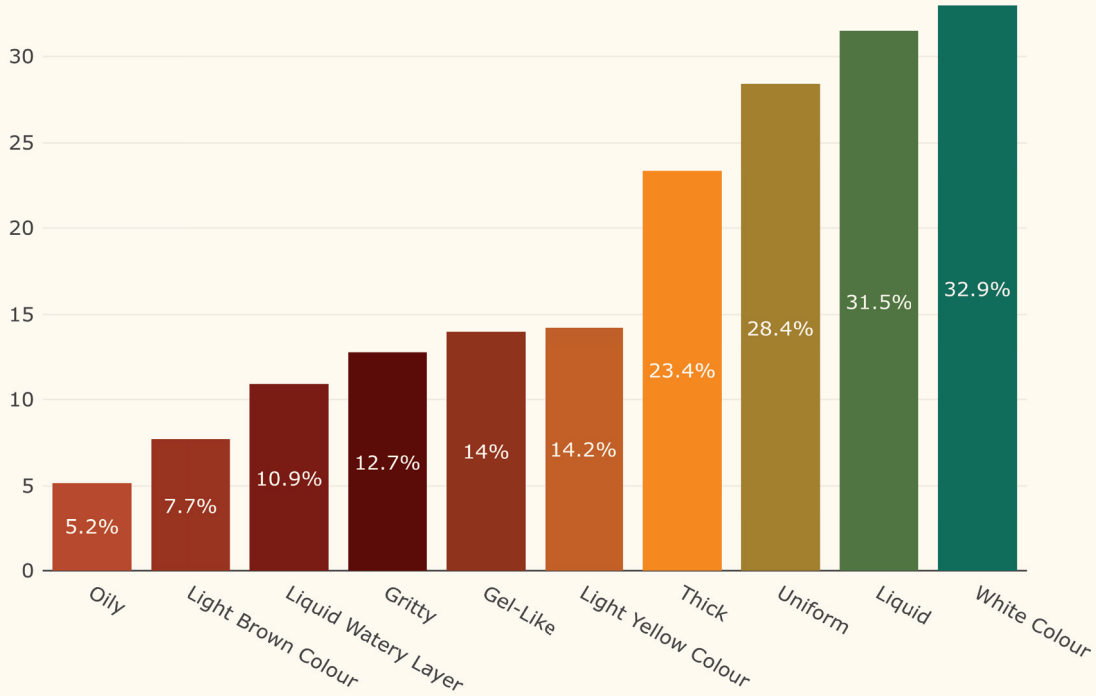
*Imagine a **Plant-Based Fermented drinkable yogurt** alternative with natural taste, not flavoured that is to your perfect liking. For each of the sensory modalities please indicate if the sensory attribute would be present in that product.*



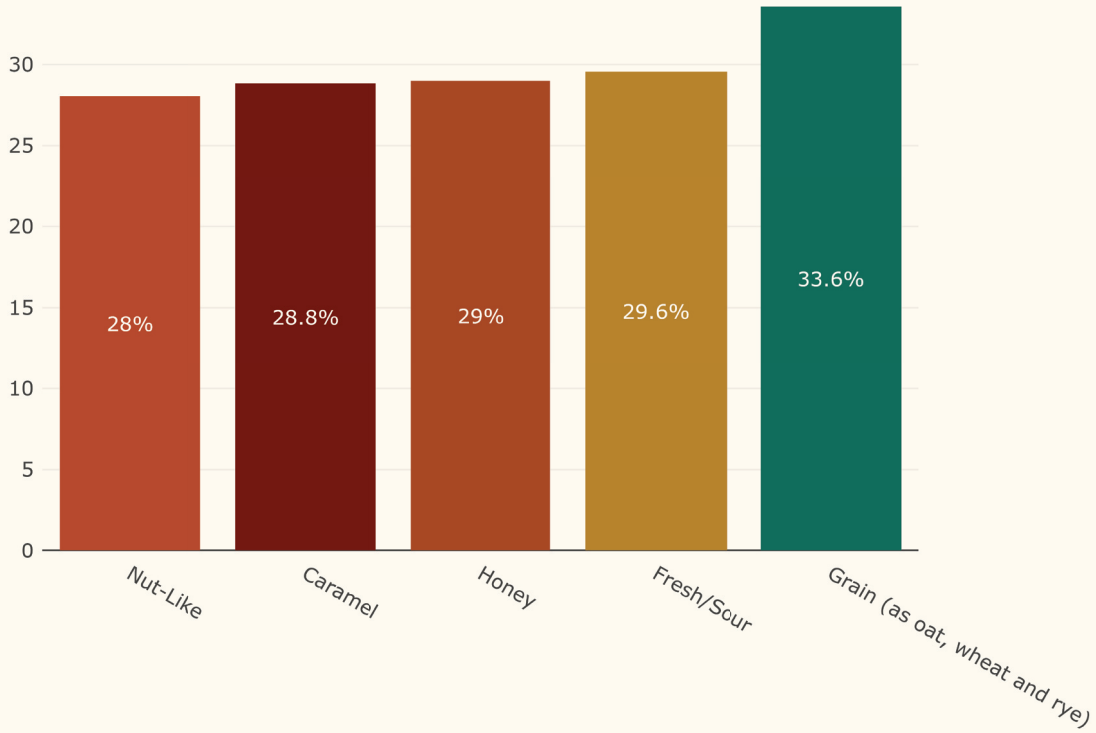
40. Taste/Flavour



41. Texture/Mouthfeel

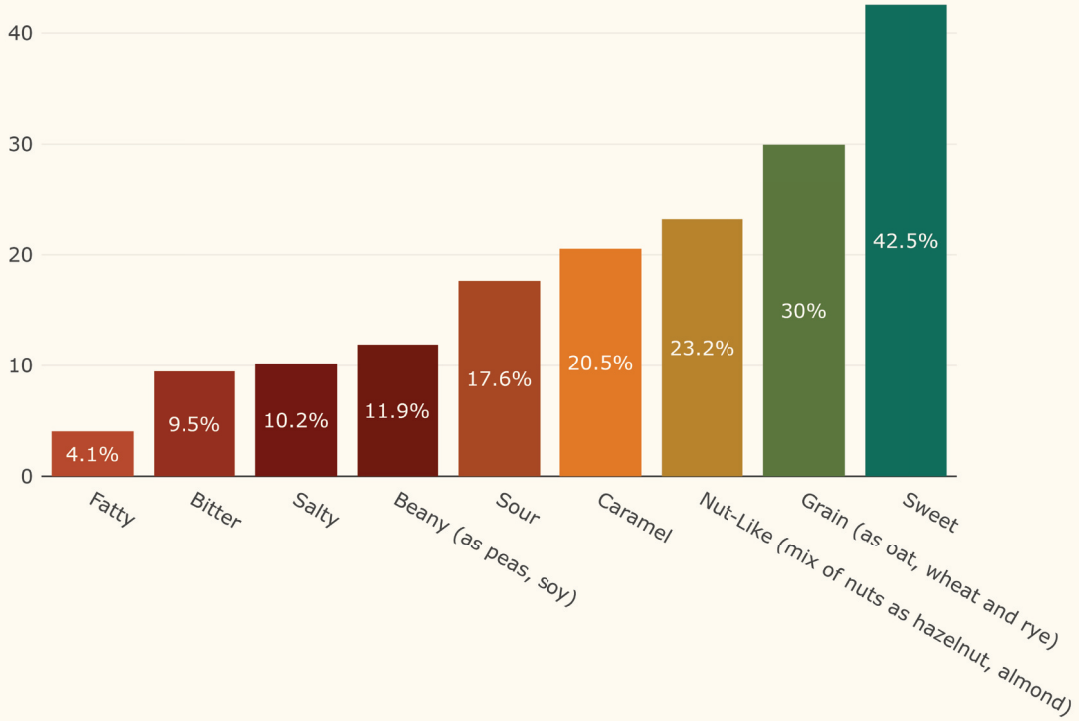


42. Appearance

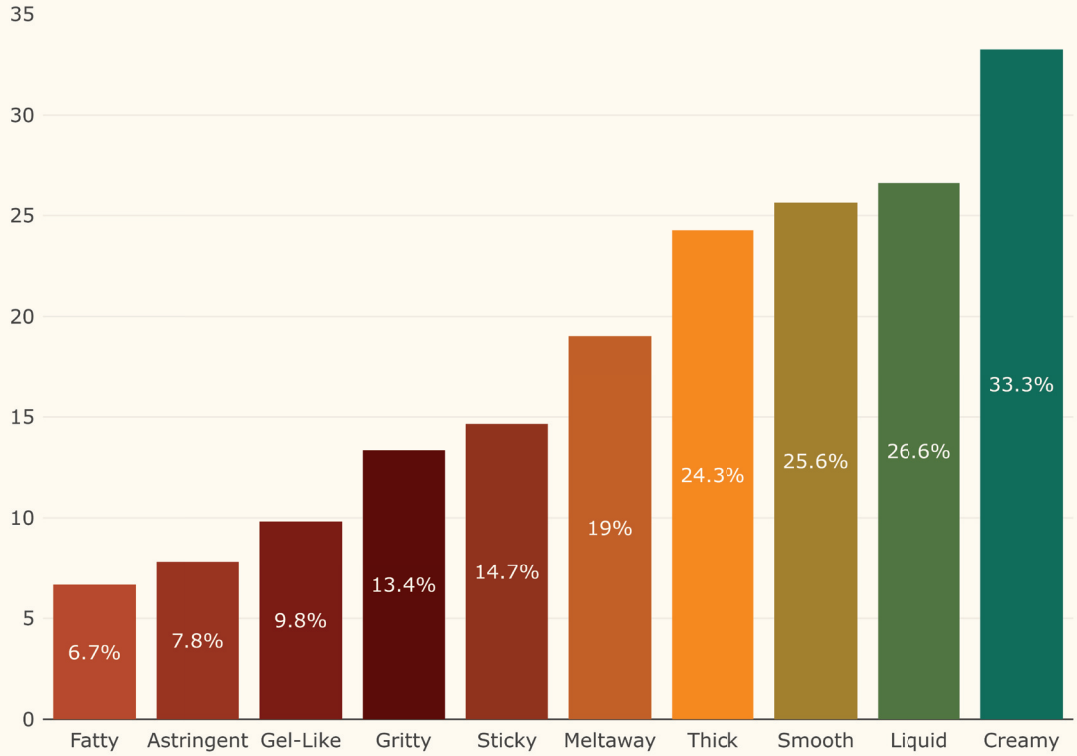


43. Odour

Imagine a Plant-Based Fermented yogurt alternative with natural taste, not flavoured that is to your perfect liking. For each of the sensory modalities please indicate if the sensory attribute in question would be present in that product.



44. Taste/Flavour



45. Texture/Mouthfeel

CHICKEN ALTERNATIVE

Appearance – colour and shape are paramount

When it comes to the appearance of fermented plant-based chicken products, respondents prioritise colour – "even colour" was the most selected appearance attribute, while "brown color" was the third most selected. In contrast, "red colour" was among the least desirable among respondents.

"Natural shape" was the second most important appearance characteristic after "even colour."

Other appearance options were significantly less desirable, with "bloody" being the least selected option.

It must smell like chicken

Respondents overwhelmingly selected "chicken-like" as the most desirable odour attribute, while all other options were of significantly lower importance.

As was also found for yogurt and drinkable yogurt products, respondents favour grainy over beany odours for fermented plant-based chicken alternatives.

Make it salty – and spicy

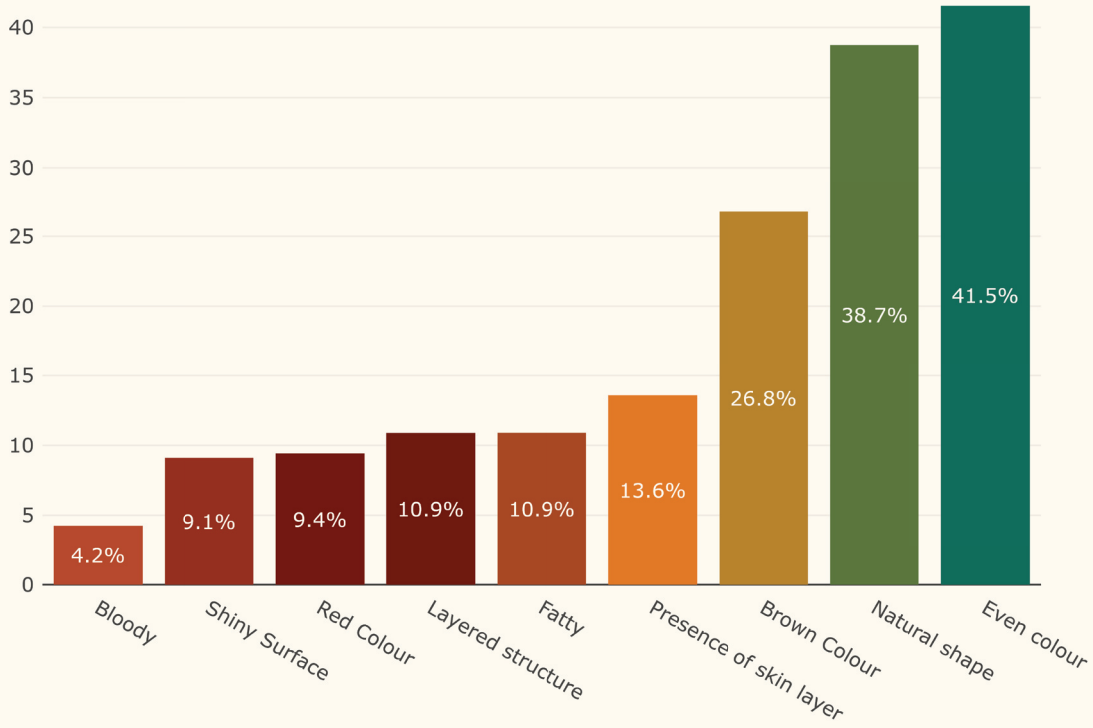
Among 15 options for flavour attributes, "salty" was the most desired by respondents. Interestingly, "spicy" was the second-most selected flavour characteristic, which scored even higher than "roasted" (third) and "smoked" (seventh).

"Yeasty," "bitter," and "sour" were the least desirable flavours for a fermented plant-based chicken alternative.

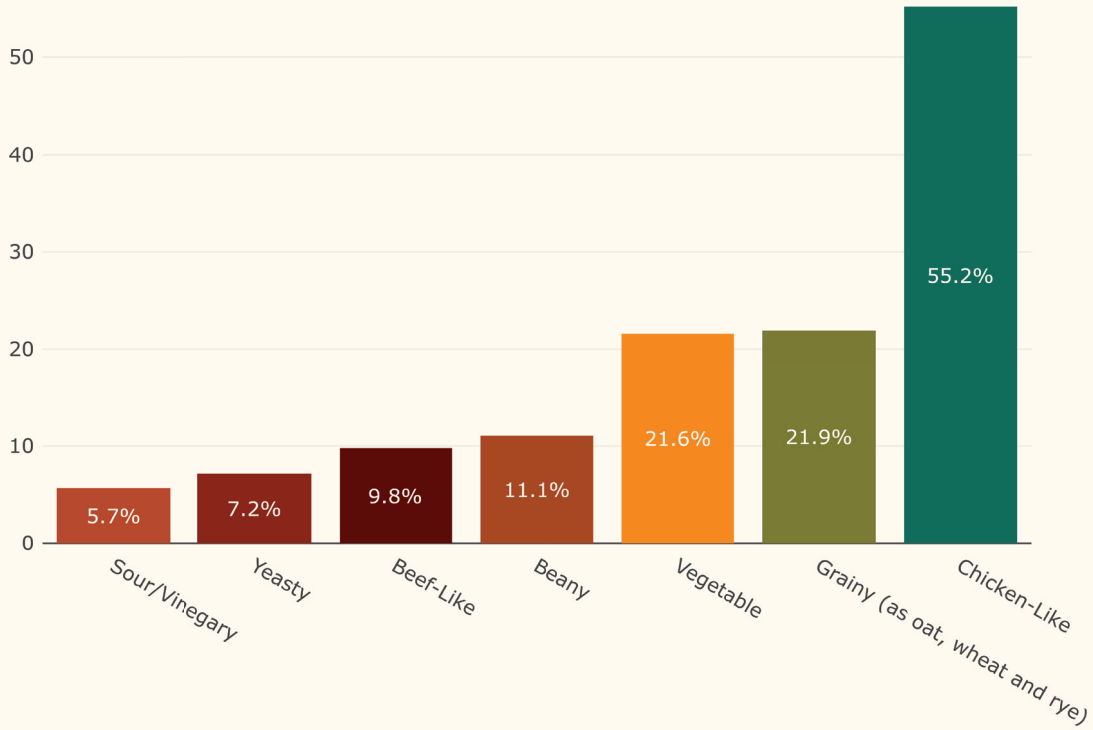
Tender and uniform at the top for texture

"Tender" and "form" topped the list of 11 texture attributes, with both being selected by over 30% of respondents. "Firm" and "juicy" were the next most important, each being selected by more than 20%.

Other texture characteristics were significantly less desirable, with "sticky" and "springy/bouncy" being the least selected.

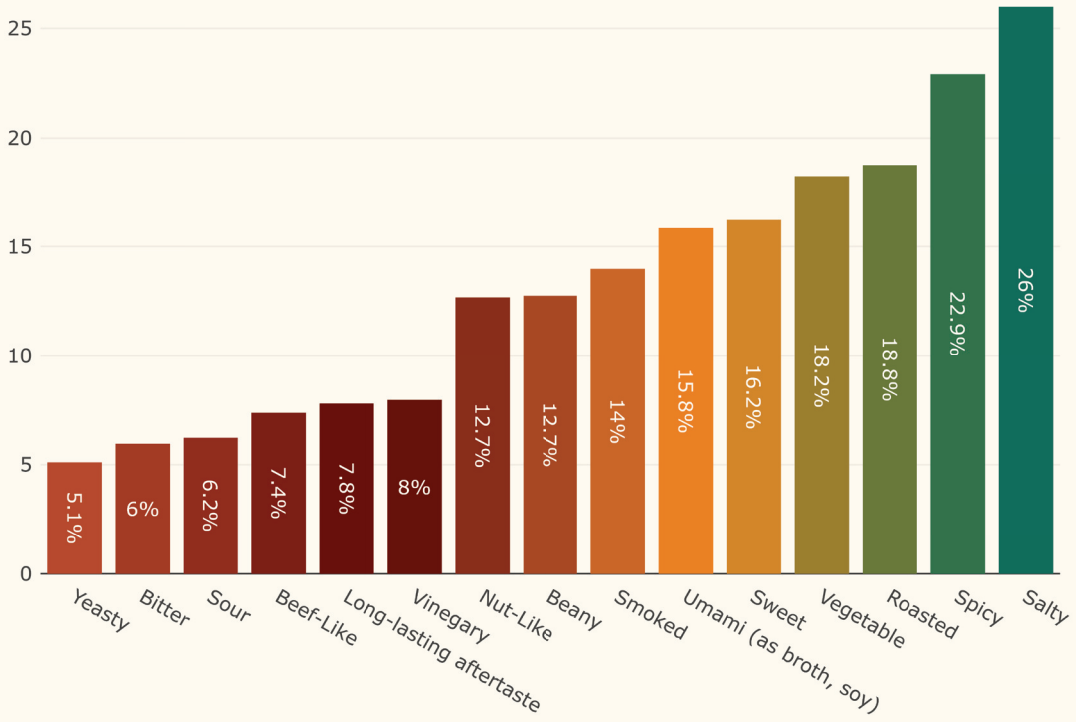


46. Appearance

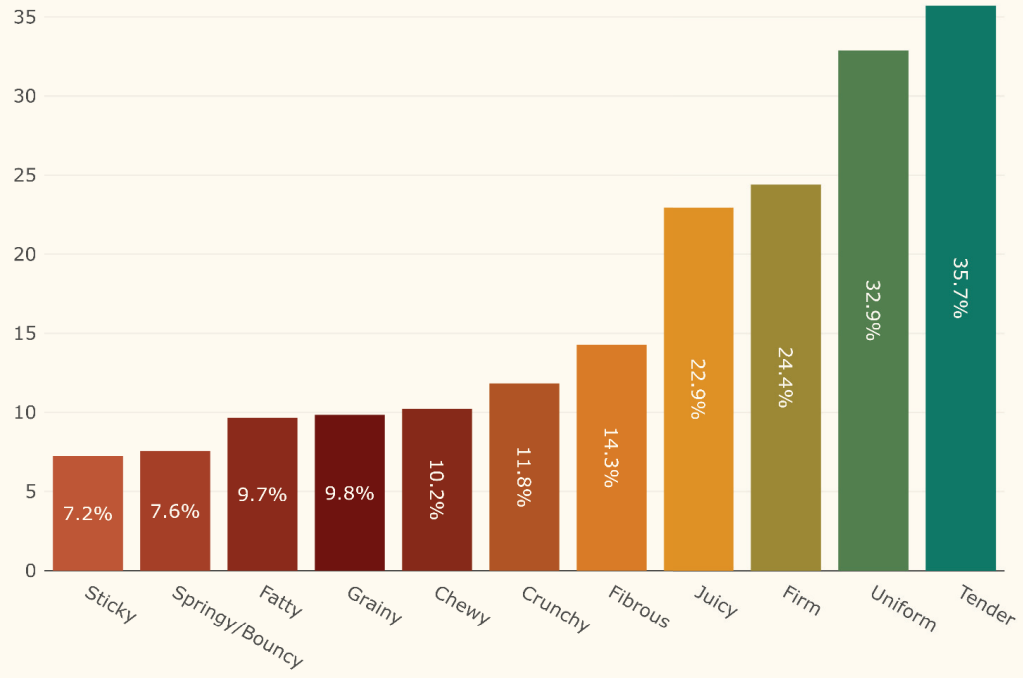


47. Odour

Imagine a Plant-Based Fermented chicken alternative that is to your perfect liking. For each of the sensory modalities please indicate if the sensory attribute would be present in that product.



48. Taste/Flavour



49. Texture/Mouthfeel

PROTEIN-ENRICHED BREAD

Air bubble size matters

When consumers see a protein-enriched bread product, they want to observe small air bubbles. This was the most desirable appearance attribute, selected by 42% of respondents. In contrast, "big air bubbles" was the least desirable attribute, selected by just 15%, while 22% selected "no air bubbles."

But air bubble size was not the only thing they cared about, as "cohesiveness" was the second most important appearance characteristic, selected by 32% of respondents.

"Moist" was also of little desirability, with only 17% indicating its presence in a perfect protein-enriched bread product.

Roasted and nutty aromas in demand

When asked to select among five odour attributes, "roasted" and "nutty" scored similarly, with approximately 36% of respondents selecting them as desirable.

"Fermented" and "malted" followed, each selected by over 20% of respondents, while "smoky" was least desirable, selected by only 9%.

It should taste fermented

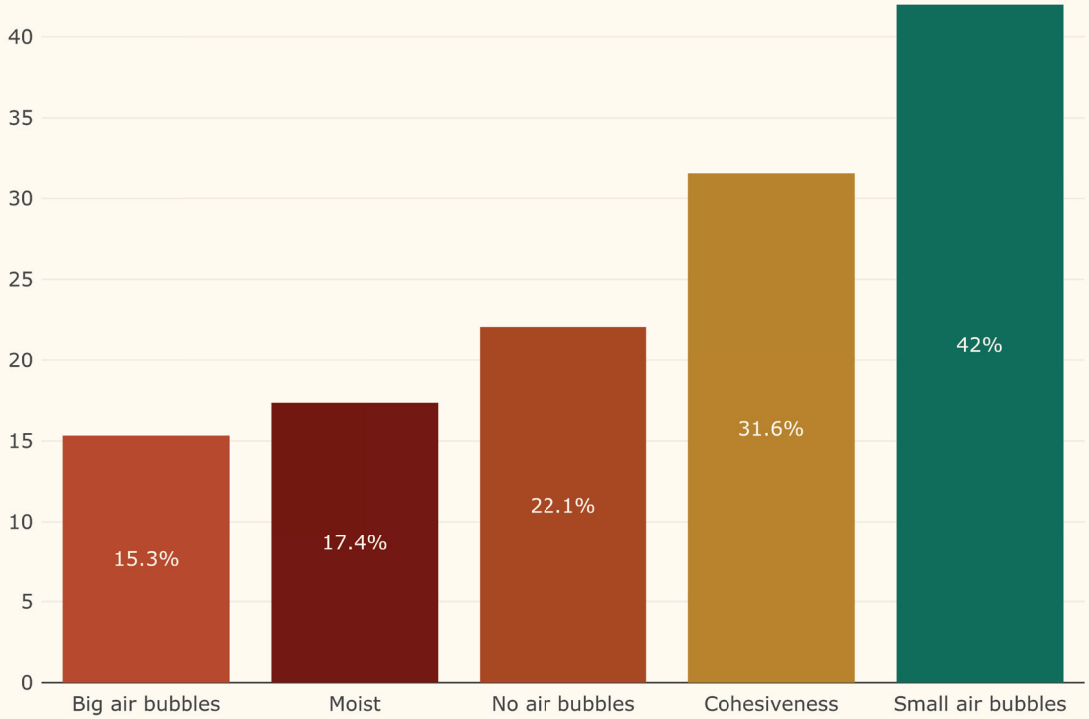
Despite "fermented" being only moderately important for odour, this was the single most desirable flavour attribute, selected by over 20% of respondents from 14 different options.

"Nutty," "sweet," and "roasted" followed with over 18% each, while "bitter," "smoky," and "meaty" were the least desirable flavours respondents wanted in a protein-enriched bread product.

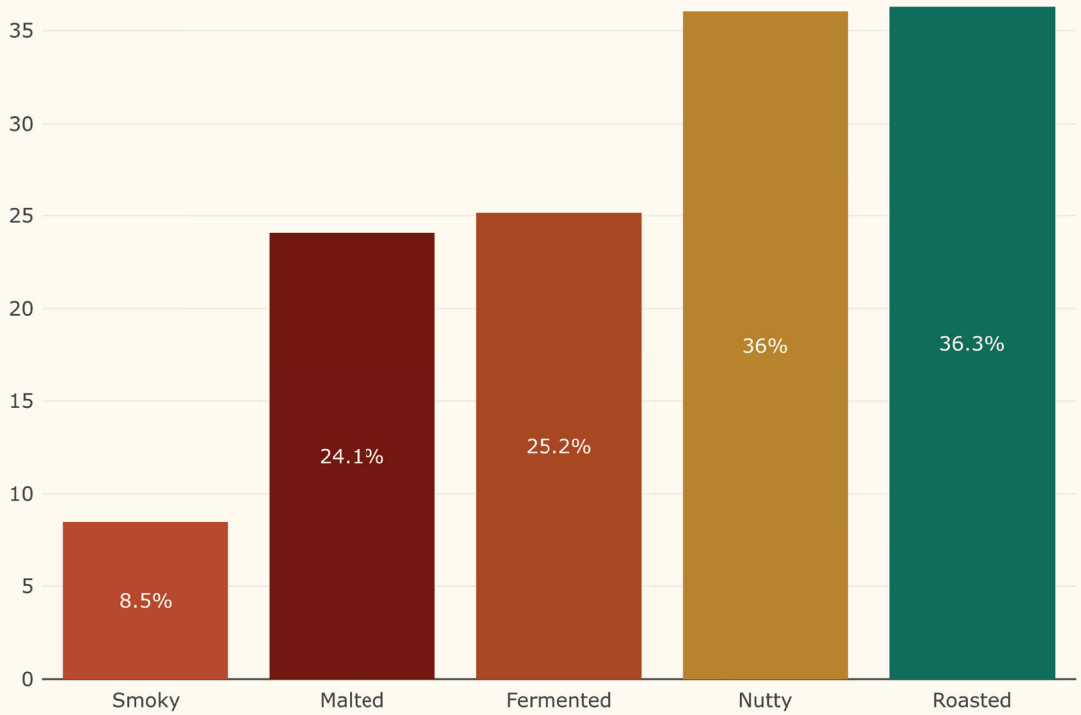
Perfect bread is both crispy and soft

"Crispiness" is the most important texture attribute for a perfect protein-enriched bread product, but "soft" is not far behind in importance. This is what respondents indicated, with the two characteristics being selected by 38% and 35%, respectively.

However, crispiness does not necessarily mean "presence of a hard crust," which was selected by 27% of respondents, making it fourth most important among eight options presented.

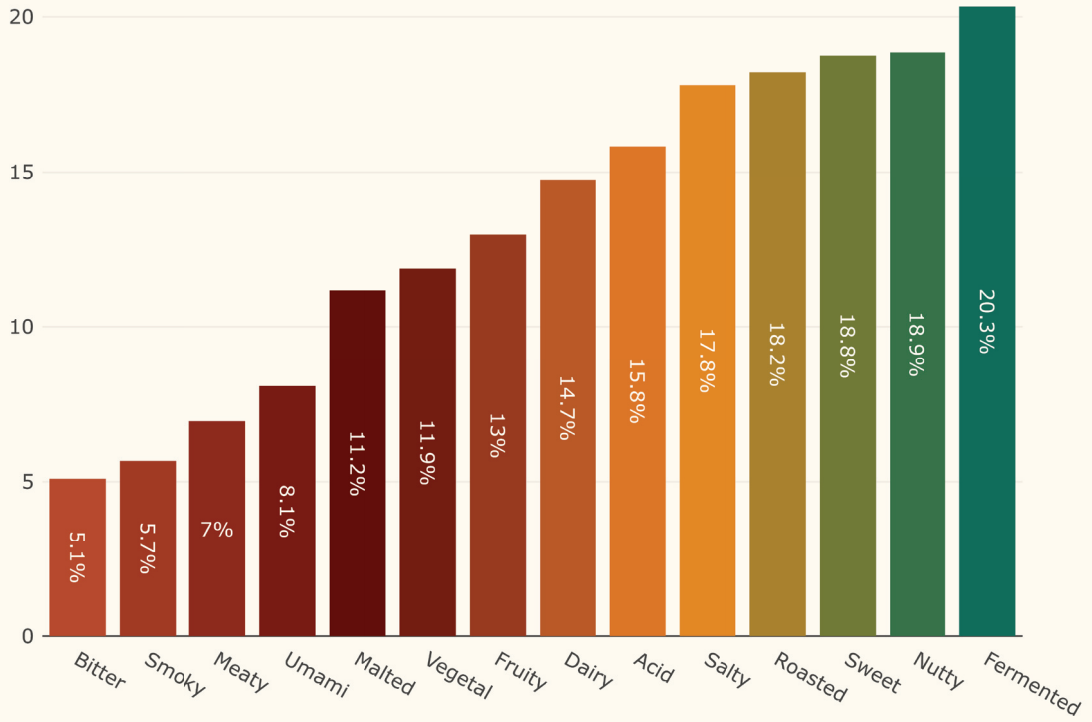


50. Appearance

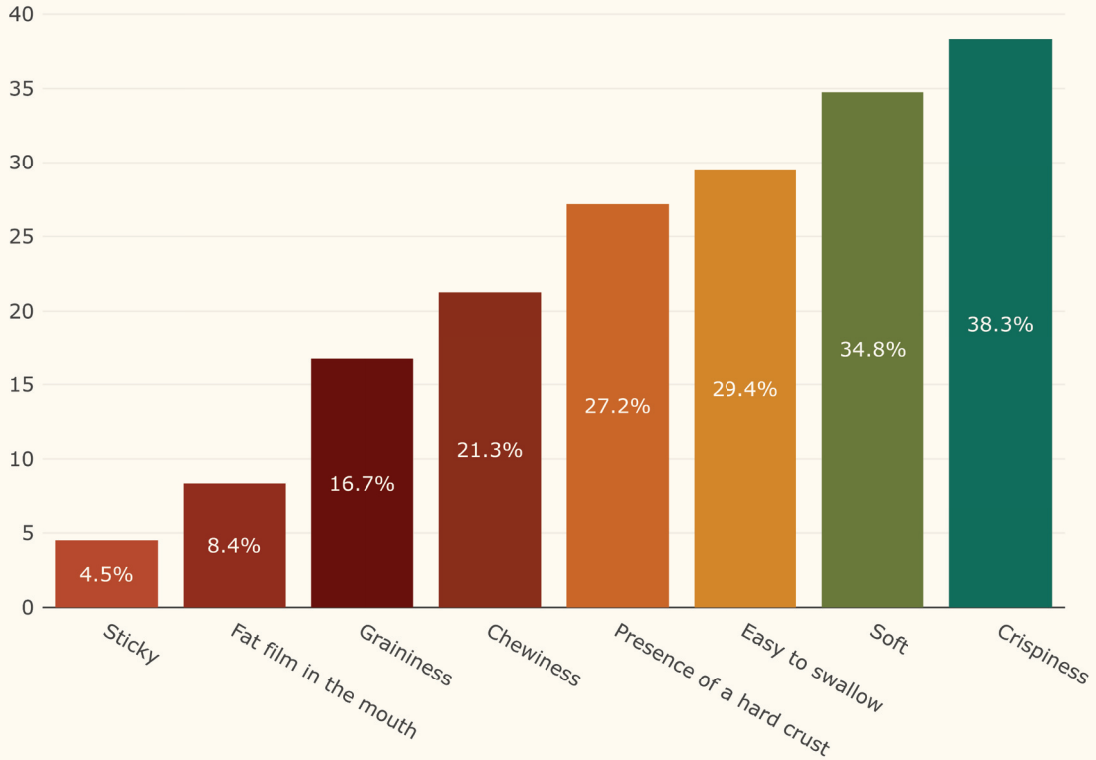


51. Odour

Imagine a Plant-Based protein enriched bread that is to your perfect liking. For each of the sensory modalities please indicate if the sensory attribute would be present in that product.



52. Taste/Flavour



53. Texture/Mouthfeel

ABOUT THE STUDY

HealthFerm is the EU-funded research project investigating innovative pulse and cereal-based food fermentations together with the health effects and consumer perception of novel fermented foods. Work Package 4 "Consumer Studies" has the following objectives:

To identify levers to promote the consumption of foods & meals based on plant-based fermentations.

To assess and monitor the changes in consumer perceptions towards plant-based fermented foods in 9 EU countries.

To achieve these objectives, two cross-sectional surveys are planned, aiming to explore consumer perceptions of plant-based fermented foods (PBFF). For this purpose, HealthFerm set up a questionnaire that addressed attitudes, trust, behaviour, and market opportunities for fermented plant-based foods. The questionnaire included socio-demographic information that will allow for segmenting and statistical modelling.

This report is based on the first wave that took place between December 2023 and February 2024 across BE, CH, DE, DK, FI, FR, IT, RO, SE. The questionnaire covered sociodemographic characteristics (sex, age, locality of residence, education level, financial situation, and dietary habits), to ensure representativeness, sufficient statistical power, and to further control for known confounding.

The survey was completed by respondents who were recruited by Enkätfabriken AB, with a total of 7,812 participants over the age of 18 and at least 750 respondents per country, equally divided amongst females/males (50% each), and within five age groups: 18-30, 30-40, 40-50, 50-60 and 60+ (approx. 20% in each).

Participants provided information about their eating habits, although only self-identified flexitarians and omnivores were asked about their consumption of meat, and their intentions towards reducing or increasing their currents consumption levels.

DEMOGRAPHICS

In total, 7812 answers were collected in BE, CH, DE, DK, FI, FR, IT, RO, SE. The mean age of the respondents was 48y (SD16). Approximately 50% of the respondents were female and 50% males, with a 0,2% of respondents (n=14) who chose "other" as sex. All socio-demographic characteristics are presented in the tables below.

DISTRIBUTION OF RESPONDENTS BY COUNTRY

Country	BE	CH	DE	DK	FI	FR	IT	RO	SE
Number	812	784	1292	768	801	817	804	889	845
Proportion	10,4	10,0	16,5	9,8	10,3	10,5	10,3	11,4	10,8

SOCIODEMOGRAPHIC CHARACTERISTICS OF THE PARTICIPANTS IN THE BASELINE SURVEY

Variable	%
Age - mean, (SD)	48,34 (16,2)
Age Groups	
18-30	16,2
31-40	19,1
41-50	18,1
51-60	19,5
61+	26,8
Sex	
Male	50
Female	50
Level of Education	
Finished primary school	5.0
Finished secondary school	25.4
Other post- secondary studies (professional bachelors, associate degree, vocational/technical training or qualification,	25.7
Undergraduate studies (Bachelors, etc)	27.8
Graduate and post-graduate studies (Masters (in BA, of Science, of Arts, etc), Doctorate)	16.1

Financial situation	
Extremely difficult	4.8
Somewhat difficult	16.9
Neither easy nor difficult	38.5
Somewhat easy	31.9
Extremely easy	8.0
Living area	
Urban	57.7
Rural	23.6
Suburban	18.7
Household members	
Single household	25.4
2 household members	33.6
3 household members	21.1
4 household members	15.0
5 household members or more	4.9

CHARTS

Chart images in this document are provided for convenience and accessibility for offline and print readers.

Interactive versions of all charts are available at the following link:

https://research.bridge2food.com/healthferm/wp4survey

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